THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 45. Thursday, July 23, 1931. No. 779.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of
THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.
Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Mechanisation and Employment.

We have been on several occasions reprimanded by theorists for our constant advocation of the modernisation and rationalisation of the foundry industry at a time when it is incapable of supporting a full complement of working staff. Yet a review of American conditions, where this movement is even more pronounced than in Europe, discloses ample justification of our endeavour. It appears that the average number of wage earners in the manufacturing industries per thousand of population, taken over the last forty years, ending in 1929, has been about 73. The highest (82) and the lowest (65) years of employment appeared in 1919 and 1921. During these four decades of intensive mechanisation, official pauperism has been halved, whilst the average *buying power* of wages per worker in manufacturing industries has increased from about 550 dollars per annum to 880. These figures do not mean dollar wages, which have increased much more rapidly.

The only weakness in our armour is, of course, the present American industrial slump, but in the light of these statistics it must be ascribed to "frozen" gold, amounting to £300,000,000, a fifth of the gold of the world lying in the cellars of New York banks. Apparently some financiers consider it good business to expend an enormous amount of energy to dig gold out the ground in one part of the world and promptly bury it elsewhere. After much study of the present economic crisis we are convinced that the whole trouble can be associated with the "time" factor. This particular phase by the way is also responsible for most differences of political thought. Each mentality or group of mentalities legislates for the moment, the near future or decades ahead. It is now becoming apparent that Germany's difficulties are to be associated with the withdrawal by foreign creditor banks of *short term* loans. Thus having satisfied ourselves that the financial crisis and the non-consumption of the present great stocks of raw materials are not attributable to mechanisation, we feel that we could not do better than quote the following stimulating paragraph from the "Iron Age"

"Those who may be hesitating to adopt a policy of plant modernisation and machine replacement, because of the fear that it may accentuate unemployment, should be reassured by a study of these facts. Improvement in mechanisation does *not* dilute employment. It reduces poverty, builds real buying power, re-establishes lost profits." Moreover, if a foundry does not mechanise, it has no guarantee that the man next door or abroad will not.

Chemical Plant.

Cast iron may well be regarded as the backbone of the materials used in chemical engineering. The size and complexity of the parts required, the necessity for freedom of attack by corrosion and erosion, the necessity for life at elevated temperatures all single out cast iron as an indispensable material for the chemical engineer. The development of special irons for special purposes is doing much to hold up the drift to more expensive materials, and it is satisfactory to see what progress is being made in this direction by British manufacturers.

This progress can be appreciated at the exhibition organised by the live Chemical Engineering Group of the Society of Chemical Industry, which has just held its jubilee celebrations in London. The exhibition was designed to demonstrate the application of various raw materials to chemical industry, with special reference to chemical engineering, and one of the five groups dealt with the metals. A special feature was the collaboration of various research bodies in furnishing suitable exhibits, over a dozen being concerned, including, of course, the Cast Iron and Non-Ferrous Research Associations.

The Fuel Research Station had some exhibits of model retorts for low-temperature carbonisation and hydrogenation of coal. The metal exhibit included alloys for use at high temperatures, arranged by the N.P.L., various items by the Non-Ferrous Research Association, including improved copper containing a minute proportion of silver for locomotive firebox stays, alloys for high temperatures, the welding of non-ferrous metals, corrosion-resisting alloys and the new lead alloys for piping and sheathing.

The exhibits of the Cast Iron Research Association included corrosion-resisting cast irons, heat-resisting cast irons and various finishing processes for furnishing a corrosion-resisting surface. For large chemical castings improvements may be looked for in better methods of mixing and melting irons, in the improvement of machinability of the high-silicon acid-resisting irons and in the generally better understanding of the material and the influence on it of working conditions.

The exhibition was undoubtedly appreciated by the numerous founders who visited it as representing a body desirous of keeping abreast of what their own and other trades are doing in one of the biggest preserves of the foundry—the chemical industry. Let us see that we keep it so.

Manhole Covers.

A West Country foundry is desirous of learning the nature of Hinde's slot-top pattern (with bolt for locking) manhole covers. Do any of our readers possess information upon this point?

XUM

The British Cast Iron Research Association.

III.—LABORATORY AND OFFICE ACCOMMODATION.

Before dealing with the services rendered by the Association to the industry, we propose to indicate the accommodation and equipment which it possesses, because the services which can be rendered are, to some extent, governed by the facilities which it has available.

When the Association was incorporated in 1921, it was entirely without capital resources, but since that date it has, by expenditure out of income, acquired capital assets valued at £4,000 to £5,000. These are housed, in the main, at the headquarters laboratories, which were occupied towards the end of 1926. The existing premises were adapted to the purposes in view and accommodate the following:—

Library and Information Bureau.

A space of approximately 500 sq. ft. is devoted to the Library and Information Bureau, which now forms the most comprehensive collection of information in the world relating to the founding industry. The Association receives regularly some 90 periodicals relating to the industry from all parts of the world, and, in addition, receives books, patent specifications, trade literature and pamphlets. These are all indexed under skilled supervision, and are available on loan. The more important periodicals are kept on permanent file, and valuable sets, dating from the earliest days of the industry, are housed in the collection. The more important foreign Papers are translated and are available on loan. The total number of volumes on the shelves is about 1,200, apart from periodicals and articles of interest to the trade removed from periodicals not kept on permanent file. The Carnegie United Kingdom Trustees recently granted the Association a sum of £600 to complete sets of periodicals issued before the Association came into being, and good use has been made of this generous gift.

All contributions to the advancement of foundry practice and metallurgy are abstracted in the Quarterly Bulletin, which is sent to all members. The abstract gives a brief statement of the scope of each article, the original of which can always be borrowed, foreign ones frequently in translated form. The Bulletin also contains a list of additions to the Library. The whole of the collection is arranged on a decimal system of classification, originally associated with the name of Dewey, and by this means articles of a specialised character are automatically brought together, and references to articles on the same subject can conveniently be consulted at one time.

The Association is gradually building up a collection of lantern slides, which are available to those desiring to lecture on the various aspects of cast-iron and foundry practice.

Offices.—For the purpose of office accommodation, for records, etc., a space of about 500 sq. ft. is available.

Laboratories.

The Association is organised so that fundamental determinations required in connection with investigations are carried out in laboratories under the control of specialists. Since the materials to be dealt with, such as cast iron and its alloys, sands, refractories, fuels, fluxes, are so complex that the investigator must be under no doubt whatever as to the reliability of the laboratory determinations, the tests have to be carried out by specialists. Three main laboratories are arranged at the Association's headquarters respectively for chemical, microscopic and mechanical testing.

Microscopic Laboratory.—The space of about 450 sq. ft. is allocated to the micro-examination of cast metals. The equipment includes a polishing machine, Reichart and Watson microscopes for visual examination, and a Swift photomicrographic apparatus for the permanent recording of specimens of particular interest. With this, magnifications up to 1,500 can be readily obtained, and the difficulties associated with photomicrographic work on cast iron are such that special technique is necessary for the production of specimens that will convey an accurate idea of the microstructure.

Chemical Laboratory.—A space of about 430 sq. ft. is allocated to the chemical laboratory. The equipment is similar to that found in any ordinary metallurgical laboratory, except that care is taken never to sacrifice accuracy to speed, and the whole of the methods adopted are such as to give exact results. Thus the whole of the determinations of carbon are carried out by direct combustion, both for total carbon and graphite, and the combined carbon is always determined as a difference figure and never by the colour test.

Mechanical-Testing Laboratory.—The mechanical-testing laboratory along with the machine tools for the preparation of specimens is housed in an area of about 450 sq. ft. The equipment includes a 20-ton testing machine for tensile, compression and transverse tests, a Brinell machine, a tensile-testing machine (the Tensometer) for very small specimens, and a repeated impact machine for test-pieces of the Stanton type and apparatus for malleable bend tests. A simple wear-testing machine for comparing the properties of various irons under dry wearing conditions has also been made. The machine-tool equipment includes a lathe, milling machine, drilling machine, various types of grinding and cutting wheels for the preparation of specimens for mechanical tests, and for sampling for the purpose of microscopic examination and chemical analysis.

Research Laboratory.—A space of about 430 sq. ft. is devoted to research work on heat-resisting irons. The equipment includes a Chevenard dilatometer by means of which thermal expansions, change points and permanent growth may be recorded on specimens up to 1,000 deg. C. Tests in various atmospheres, air, carbon dioxide or carbon dioxide and sulphur dioxide are carried out in various resistance furnaces up to 1,000 deg. C. This is the test used for repeated heating. A potentiometer of the Cambridge type is used for thermal curves.

Experimental Foundry.

Space is available for the development of a small foundry where experimental melts may be made, and it is hoped during the next few months to raise funds which will assist in equipping this section. Hitherto the Association has been mainly dependent on facilities furnished by members and these have been given in a generous measure. At the same time the melting of comparatively small quantities of material, especially of unusual composition, always presents difficulties in ordinary cupola plant, and it is hoped to provide suitable furnace equipment in which this may be carried out. At present melts cannot be made in the laboratories of greater weight than about 20 lbs.

Sands Laboratory.

The whole of the work carried out by the Association on moulding sands is done in the Refractories Department of the University of Sheffield, where two rooms are provided for the chemical analysis, physical tests, mechanical tests and elutriation of all types of sands and refractories under differing conditions with respect to moisture, ramming density, grain size, etc. Moulding sand used in casts made from the crucible furnace at the laboratories at Birmingham is conditioned in a Simpson laboratory-size mixer, kindly supplied by August's Muffle Furnaces, Limited.

Falkirk Laboratory.

The Scottish laboratory of the Association, formerly the Falkirk Technical Institute, is also equipped for chemical and mechanical testing and microscopic work, the principal feature of the apparatus being a 50-ton electrically-driven Avery machine for tensile, transverse and compression tests.

The total accommodation occupied and available at headquarters, apart from the accommodation at Sheffield and Falkirk, is 6,000 sq. ft., arranged to form a compact and homogeneous organisation.

Random Shots.

That romantic little lyric of syncopation, "Dancing with Tears in My Eyes," might conceivably have been inspired by a dance marathon such as that concluded in Paris on Monday. The o'clock at which the contest ended was four in the morning, when the surviving couple were carried from the floor whereon they had "danced" for 752 hours, and, jointly, had worn out twenty-eight pairs of shoes. Little show of "the light fantastic toe" could there have been after the first few hours of the competition; and whatever tripping there was you can be certain was not intended! Creep test rather than dance marathon would more accurately describe the proceedings.

* * *

The curious and unfortunate thing about all these Silly-Season contests is that invariably they are quite unproductive. Their organisers are apparently unwilling that human energy should be expended usefully. In the main, competitors' efforts are confined to long-distance tip-toeing or continuous tree-sitting (in which the last one to perform the Newton's-apple trick is adjudged victor)—performances calculated to demonstrate neither the progress nor nobility of civilisation. Perhaps productive effort is rather too reminiscent of work to attract the normal type of participant!

* * *

It might perhaps be instructive, in the furtherment of human-fatigue study, to organise one of these contests in industry. In the foundry, for instance, all the moulding-machine operators could partake in a "knock-out" competition for the record continuous production of moulds, each man not to retire until he is exhausted or his machine breaks down. (Conveyors would, of course, be necessary to clear the machines of finished moulds.) And when this contest was concluded, and the foundry floor covered with moulds, the teemers and cupola men could commence. It would satisfy me to know how the output per sq. ft. of floor area under these conditions would compare with the normal figure.

* * *

To what lengths will not protective tariffs go! The Canadian Budget, it is said, contains a proposal for a practically prohibitive duty on American magazines. This tax is intended not so much to protect the interests of the Canadian publishers or the literary tastes of Canadian readers as to minimise the advertisement of American products in our Dominion.

* * *

One speculates exactly what type of magazine is intended to be kept out. Surely not the fiction magazines obtainable at our second-hand bookstalls, for the specimens which have passed, rapidly, through my hands appear to specialise exclusively in the announcements of correspondence colleges. How to become leaders of men, how to cultivate dynamic personalities, how to make BIG money, are amongst the most persistent offers of these "colleges." But despite the abundance and frequent appearances of such offers, no wholesale increase in the number of America's dynamic personalities has yet evinced itself. But there must be BIG money to be earned in their cultivation!

MARKSMAN.

A New Centrifugal-Casting Machine.

Messrs. Craven Brothers (Manchester), Limited, Reddish, Stockport, the machine-tool engineers, have for some time been manufacturing centrifugal castings for gear wheels, rings, etc., the outcome of which has been the development of an improved model centrifugal-casting machine for the production of such castings. Both ferrous and non-ferrous metals can be spun. Especially is this process suitable for bronze gear blanks, rings, etc., up to 3 ft. in dia. or more. Greatly increased life and service is obtained from the spun casting, associated with an almost complete elimination of defective returns and a reduction in production costs.

This machine (Fig. 1) consists of a rotating table *J*, bolted to a suitable spindle *N*, which is carried in roller bearings and revolves at definite speeds, these speeds being variable to suit conditions for any given diameter of ring which has to be cast. The spindle *N* is securely bolted to the table *J* and has a washer of suitable insulating material *K*, interposed between the joint faces. This washer prevents any excess heat from travelling to the bearings via the spindle.

This revolving unit is carried in a massive cast-iron housing, designed to damp out vibration and

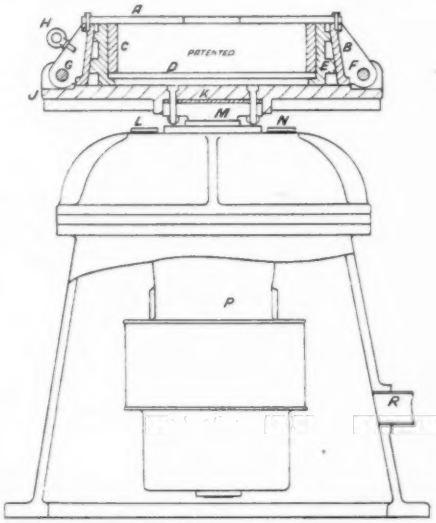


FIG. 1.—SECTIONAL ELEVATION OF THE CRAVEN CENTRIFUGAL-CASTING MACHINE.

FIG. 2.—A NEW TYPE OF CENTRIFUGAL-CASTING SHOWN IN SECTION AT FIG. 1.

completely to enclose all bearings, etc. The motor *P*, which has an integral flange, is bolted securely to the underside of the housing, and drives direct to the spindle by means of a flexible coupling, which prevents any whirling due to mal-alignment or expansion of the shafts. The cast-iron housing with motor *in situ* is bolted to a hollow cast-iron base, thus completely protecting every moving part from the dust which is invariably present in a foundry.

Careful attention has been paid to the cooling of the table and spindle, which plays an important part both in obtaining uniform casting results and in the life of the revolving members. This cooling is done by air, which presents the cleanest and cheapest method, and is extremely efficient.

The motor *P*, which is of the pipe-ventilated type, draws in air through the inlet pipe *R*. This air is circulated round the motor windings, and discharged into the inside of the spindle housing, where it is picked up by a fan mounted on the spindle, and blown against all faces which require cooling. Finally it is discharged through the outlet holes *L* and *N*, and impinges on the underside of the table *J*. The table is equipped with several spiral vanes which are so shaped that they throw out the waste air from the centre to the periphery, thus exhausting the air from the housing, and at the same time cooling the table. It can be seen from this description that a supply of cold air is continually circulating through the machine, and the result is most satisfactory. Great care has been taken to provide means of preventing any dirt or dust from being carried in with the air at all inlet and outlet points, and the pipe *R* is usually carried to the outside air as an additional precaution. The mould, which has been arranged for expeditious handling, functions in the following manner:— A hinged casing *B*, which is conical in its bore, is secured to the table by means of two substantial hinge pins, diametrically opposed. A locating ring *E*, which registers in the conical bore of the casing *B*, and carries a metal mould ring *C* and a bottom plate *D*, and the necessary cores (not shown), comprises the mould proper. A top plate (A), which is permanently fixed in position, serves to hold down the cores and prevent them floating upwards.

By removing the pin *C*, which is arranged for easy withdrawal, and lifting the casing *B*, by means of the eyebolt *H*, the conical locating ring can be removed with the casting, etc., inside it, by sliding it from the table on to the floor. To reload the machine it is merely necessary to push another locating ring into position, complete and ready to be cast. It will be evident that, by using two of these locating rings, continuous production can be obtained as one ring can be loaded while the other is in the machine, and *vice versa*.

Another important point is that all crane service is eliminated, as one man can easily lift the casing by putting a bar through the eyebolt *H*.

Auxiliary Equipment.

Lubrication to all moving parts is carried out by means of a grease gun, which forces grease under pressure to all bearings, etc. The electrical equipment on this machine consists of one 7½-h.p. variable speed motor of the vertical spindle type. The controller gives a definite series of speeds, in nineteen equal steps. The circuit breaker is arranged for operation to be controlled by a small switch, which, when operated, closes the circuit breaker and energises the shunt field to enable light dynamic braking to be applied when the control handle is brought to the off position.

The machine can also be arranged for semi-automatic control of the push-button type. The motor can be run up to any speed required by keeping the "start" button depressed, and when the button is released the speed will be automatically held. On pressing the "stop" button the motor runs down through all the speeds, thus bringing the controller into position for the next sequence of operations.

Control gear is also available in which any speed of the motor is held for a definite time, after which it will automatically drop to the next speed and continue to run at that speed for a given time. This control can be arranged to give 4 such steps in the speed, ranging in time from 1 sec. to 2 min.

Publications Received.

Northern Coke Research Committee Annual Report, No. 2.—This year's report discloses that experiments have been made using dilute ammoniacal liquor for quenching the coke as it leaves the ovens. The general properties were unaffected, except the shatter index seems to be lowered.

Institution of Mechanical Engineers, Proceedings, 1930, Vol. II. Published by the Institution, Storey's Gate, St. James's Park, London, S.W.1.

A Paper by Mr. V. E. Pullin, on "X-Rays in Engineering Practice," is included and has much interest for steel founders.

The Strength of Electric Arc Welds in Structural Mild Steel, by R. R. BLACKWOOD. Published by the School of Engineering, University of Melbourne.

This publication was sent to us by Charles Bingham & Company, 34, Victoria Street, Westminster, S.W.1, because the matter contained therein relates to tests on an Australian brand of electrodes (E.M.F. Electric Company, Limited), of which they have secured the British rights. It is interesting to record that a Dominion development of this character is so outstanding that experts in the Mother Country feel that it is worthy of commercial development at home. Whilst there may be other cases, we cannot readily bring one to mind.

The author of this pamphlet is lecturer in Agricultural Engineering at the University of Melbourne, and he describes a series of tests of side and end welds under axial loads. It is because the tests on this Australian make of electrodes were so good that the British firm has negotiated their sale in Great Britain. Copies of the pamphlet are available from the British distributors.

Aluminium in Architecture and Decoration.—Published by the British Aluminium Company, Limited, Adelaide House, King William Street, London, E.C.4.

There are but two pages of literary matter in this 24-page brochure, but in them are condensed more selling points for the aluminium foundry than would be thought possible. For instance, it is stated why aluminium castings for spandrels are cheaper than stone carvings and bronze; that weathering actions can be varied to give various artistic results; that rain washings are without influence, and so on. It is interesting to note that for internal decoration aluminium sheet mounted on a core of plywood is available, and the thought arises that this material might be very useful for pattern boards, which are now quite often made of multi-ply wood.

The feature of this brochure, however, is the collection of illustrations which show how aluminium is being used in pure and applied art. Whilst primarily intended for architects, we suggest that every aluminium founder should procure a copy, in order that he may realise the vast importance of the field opened to him in the supply of art castings.

Rehabilitating the Light-Castings Industry.

NEGOTIATIONS WITH MERCHANTS.

In pursuance of the negotiations that have been taking place for some months past between the ironfounders and merchants in regard to the possibility of a working agreement which should govern the distribution of light castings, a very important and representative meeting between the British Ironfounders' Association and representatives of all the merchants' associations in England and Wales was held in London on Thursday, July 16. The importance of the occasion was fully recognised by all those who were present, and a frank and friendly discussion took place.

Whilst the desirability of an agreement which should do something to bring prices upon a more economic level was generally recognised, particular stress was laid at the meeting not so much on the details of agreement, as these, in spite of inevitable differences of opinion, are capable of mutual adjustment and compromise, as on the manner in which such an agreement could be carried out and enforced throughout the trade generally.

It was unanimously realised both by manufacturers and merchants that an essential preliminary condition of any such agreement being brought into force must be the active co-operation as members of the British Ironfounders' Association of a hundred per cent. of all the manufacturers who count, not merely in regard to the actual number of firms, but also in regard to the output of the classes of goods which it would be proposed to control.

It can be admitted, therefore, that those firms at present remaining outside the B.I.A. hold, as it were, the key to the situation, and it really is a matter for them to decide whether they will assist in promoting the greater prosperity of the industry as a whole and help in pulling it out of the uneconomic slough of despond into which it has fallen, or whether matters are to be allowed to drift from bad to worse.

As a result of the discussion which took place it was quite obvious that an agreement was unanimously desired by all the manufacturers and merchants, and that an agreement which would be satisfactory to all parties was well within the bounds of practicability, but there neither could nor would be any such agreement until the preliminary condition already referred to is fulfilled.

It was decided to press on with the details of the agreement, and a smaller committee was appointed for this purpose which is to report finally to the main conference, which will meet again early in September. There will, therefore, be no excuse for any of the outside firms to say that they did not know what the nature of the proposed agreement will be.

There is certainly no intention to exploit the public so far as prices are concerned, even if this were possible; but it is obvious that both manufacturers and merchants should have a fair deal, and should be able to carry on their business on the basis of a reasonable return rather than that the uneconomic levels to which the industry has sunk in recent years should be even further intensified.

So far as the creation of a better understanding between manufacturers and merchants is concerned, there is no doubt that the meeting was most encouraging, and the proceedings were entirely harmonious throughout. Equally there is no doubt that a genuine desire exists on the part of all concerned to avoid the mistakes and to get rid of the suspicions of the past, and once a satisfactory agreement is settled to endeavour to carry out its terms both in the spirit and the letter.

The hope was expressed that it may be possible for the outside firms to meet together in the near future and to see whether in the light of the new situation and the prospects of better times which lie before the industry if the present negotiations are crowned with success, they will not now agree to give their active co-operation, and no longer remain an obstacle to the progress which it is hoped to make on these lines.

Spelter Starts to Climb.

By "Onlooker."

It seems a long time now since spelter began to make new low records, which finally culminated in a quotation of £9 13s. 9d. for spot and £10 5s. forward on June 4. Sentiment then began to improve on rumours that progress towards the formation of a zinc cartel was being made, and with the coming of the Hoover plan there was a further advance to £13 3s. 9d. and £13 16s. 3d. on July 3. The gain proved to have been too rapid, however, and profit taking followed, since when the tone of the market has been irregular. At the time of writing the definite news that a cartel has been formed is helping the quotation, and £13 for October shipment has been reached.

Agreement upon curtailment in Europe at the rate of 40 per cent. is reported, while Canada, Mexico and Australia are to reduce their exports to the old world by a like amount. United States production is not mentioned, but this is not an important factor on the European market. Europe draws heavily on Canada and Australia for electrolytic zinc, and Mexico sends a big tonnage of Prime Western, while, of course, the big producers here are Germany, Belgium and Poland. Stocks are everywhere heavy, the warehouse holding in this country alone being some 15,000 tons, but one of the first effects of curtailment ought to be to compel withdrawals from warehouse and a fairly rapid reduction in the existing onerous reserves of the metal. The presence of this surplus metal, together with the position which is known to exist at many makers' works, has been responsible for depressing the price of spelter to an uneconomic level, and this factor had already compelled a certain amount of curtailment.

A reduction in spelter output would, no doubt, have come in any case, for, as already mentioned, the selling price had fallen so low that for a great many interests a margin of profit no longer existed. Certain properties had already "put up the shutters," while other interests were on the point of closing down when the turn in the price came. A beginning had, therefore, been made in the elimination process, but no doubt many firms would have continued to put off the evil day, and every short-lived rally would have prolonged the situation. Cartels for cutting down production with a view to securing a higher price are not as a rule popular, nor for that matter invariably successful, but, as far as zinc is concerned, the course taken is probably the best in the circumstances.

The arrangement made amongst producers is satisfactory as far as it goes, and will definitely prevent any return to the low level ruling in June, but equally certainly an advance to a higher level will not be achieved unless some improvement occurs in the rate of consumption, which for months has been on a very poor scale. The galvanising trade has been hard hit, and, although a slight improvement is now being registered, the position remains unsatisfactory and leaves plenty of room for improvement. In the brass trade, consumption of spelter, both C.O.B. and electrolytic, has been at about 50 per cent. of normal, while no improvement is as yet noticeable.

In spite of all these doubts and difficulties, an optimistic view is being taken of the spelter situation, and in well-informed quarters an advance to £15 or £16 in the near future is predicted.

The New G.E.C. Ironclad-Switchgear Shop.

It is now generally recognised that reliable and properly-designed ironclad switches and fuses are essential adjuncts to all industrial electric equipments, and the demand for this class of gear has consequently increased to such an extent that the General Electric Company, Limited, has found it necessary to enlarge its manufacturing facilities by the erection of a new ironclad-switch assembly shop.

The lay-out of the new shop has been planned on the most modern lines for the efficient quantity production of a complete range of totally-enclosed switch and fuse gear, distribution boards, etc., for foundries, mills, factories, shipyards, workshops, and for use in exposed positions.

The new assembly shop is 380 ft. long by 60 ft. wide, covering a floor area of 22,800 sq. ft., and has a very spacious appearance due to the absence of supporting columns for the 60-ft. single-span roof. The utmost use is made of natural illumination from the north lights of the roof and from the large windows running the entire length of the walls on each side of the shop. Efficient artificial illumination is obtained at night by the well-known G.E.C. factory-lighting system installed. Large ventilating cowls automatically extract the vitiated air, fresh air being admitted by horizontally-hinged window panes opening along their upper edges so as to minimise drafts by directing the incoming air upwards.

At the north end of the shop is situated the stores, where the component parts of all the various types of ironclad switches and fuses are received from the machine shop below. A belt conveyor is installed which runs down the centre of the shop, the assembly benches being arranged transversely along each side. The longitudinal belt conveyor is employed for the transport of raw material from the stores at the north end of the shop to the assembly benches, and of finished products from the benches to the inspectors and packers at the south end of the shop.

The utmost care is taken in all stages of assembly to ensure that the apparatus will be capable of satisfactory operation under the most arduous service conditions, samples being frequently taken at random from stock for tests under actual working conditions.

Foundry Workers' Wages.

As a result of a conference of parties held in Glasgow on July 15, a settlement is now likely in the wage dispute between the National Light Castings Federation and the trade unions concerned in the ironfoundry industry in Falkirk and district.

The employers have agreed to drop their idea of posting notices intimating a wages reduction, and have appointed representatives to a joint committee with the trade unions to work out a settlement, The report of this joint committee will be considered at a further conference, to be held on July 28.

The employers originally asked for reductions of 6s. a week in the wages of piece workers, 4s. for time workers, and 2s. a week for labourers. This was resisted by the unions. There are nine trade unions involved, but the principal organisation concerned is the Ironfounding Workers' Association, most of whose members are employed in the Falkirk area. Any settlement reached, however, will apply to the light-castings industry throughout Great Britain, in which over 12,000 men are engaged. It is contended by the employers that foreign competition and the reduced demand for household baths and similar articles had compelled them to endeavour to obtain a reduction in operating costs.

Sands and Sand-Testing.*

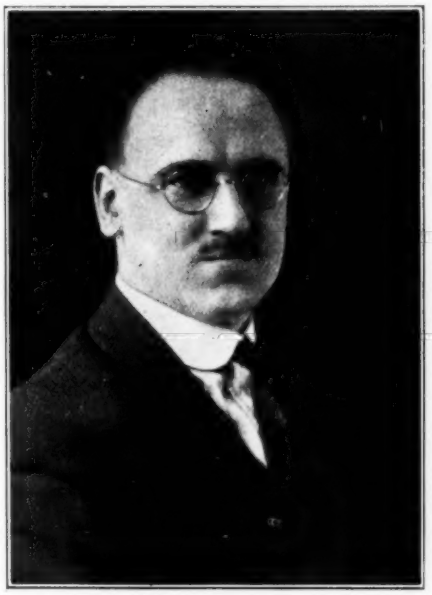
By J. G. A. Skerl, D.Sc., F.G.S.

[*This Paper is an abbreviated summary of research work on raw moulding sands typical of those in which 90 per cent. of iron and non-ferrous castings are made. Seventeen samples were examined, for example, from Kingswinford, Erith, Southampton, Scotland, Pickering, etc. A list of experiments which have been carried out on each sand is given, but only a few are discussed in detail. The methods and apparatus for the testing of the mechanical constitution, strength, permeability and refractoriness are described, and the results of these experiments given and discussed. The influence of ramming, milling and moisture content is stressed, and some examples of the practical foundry value of the results are given.*

Some of the conclusions are as follow: (1) *Every sand has a definite moisture content at which it is strongest in the green-sand condition. This moisture content is not so great as that required to give the strongest sand after drying.* (2) *Moulding sands are generally most permeable when they contain the moisture content at which they are strongest in the green condition.* (3) *Ramming increases strength and decreases permeability, whilst efficient milling increases strength but does not decrease permeability.* (4) *The permeability of a moulding sand is largely governed by the silt content, the material coarser than the bonding material but less than the coarse sand grains.* (5) *The strength of a moulding sand is increased about 20 times by drying.* (6) *The bonding material is the least refractory constituent of a moulding sand, and, other things being equal, the greater the percentage of bonding material, the less refractory the sand.* (7) *Milling, amongst other considerations, improves the surface of castings. The Paper is illustrated by photographs, figures and tables.*]

It is only during the last twenty years that the British foundry world has interested itself in the study of one of its most important raw materials, the moulding sand into which its products are cast. During this period of time, however, much has been learnt and published. The pioneer work of John Shaw and A. L. Curtis, which has never been acknowledged or appreciated by the industry to the extent that it deserves, was interrupted by the Great War. The exigencies of the moulding-sand problem during the period 1914 to 1918, especially difficult for the steel foundries who received most of their supplies from the Continent, were such that the Ministry of Munitions appointed Prof. P. G. H. Boswell, F.R.S., as its scientific adviser in order that new sources could be found and the best use made of the known supplies of moulding sands. Prof. P. G. H. Boswell obtained a large amount of extremely important data which has been summarised in his "Memoir on Refractory Sands," which is the recognised text-book of all research workers on moulding sands. Since the war the work of O. Smalley, F. Hudson, H. V. Grundy and A. Philips, A. Rhydderch and others has been presented to the Institute, and shown that the interest in the subject has not waned; indeed, year by year the increasing number of Papers dealing with moulding sands proves the importance which the foundry industry attaches to the subject. It should be noticed that until recently all workers on moulding-sand research have confined their attention to the properties of the new natural sands because it has been seen that only by adequate concentration on the pure raw material could data be obtained which would be of service in investigating the sands actually used in mould production.

In 1924 the British Cast Iron Research Association appointed the author to work under the general supervision of Mr. W. J. Rees, B.Sc., F.I.C., in the Department of Refractory Materials, University of Sheffield, and to carry out a systematic study of the refractories, especially moulding sands, used for ironfounding. In Papers and in discussions in the Institute on moulding sands, speakers have often stressed the desirability of a standardised method of testing, and it was to this aspect that attention was first given. The chief desiderata of such test methods are that they should be suitable for the testing of the extreme ranges of moulding and facing sand used in this country under research conditions, and that, if possible, they should be of value as foundry-control tests. The latter clause meant that the apparatus must be robust and cheap. Every available British and foreign method and means of testing moulding sands was examined, and it was found that most of the ideas had to be discarded because they were not adaptable for research purposes or were only suitable for the types of sand with which the originator was familiar. The methods finally evolved are to be found in Research Report 73 of the B.C.I.R.A., which is also available for general circulation. It will be found that the methods are, in general, modifications of schemes evolved by other workers to whom reference is made. It should be pointed out that the B.C.I.R.A. research methods had been in use in the Association's laboratories for nearly five years on the greatest possible variety of sands before the Sands and Refractories Sub-Committee allowed of their publication a year ago. In spite of this fact it should be stated that the methods are not final or complete, for new methods and improvements are constantly under review, the results of which will be seen in the new edition of Research Report 73, which will shortly be issued.



[*Photograph, Ethel Eadon, Sheffield.*]

DR. J. G. A. SKERL.

Dr. Skerl was born in London and educated at Westminster City School. In 1920 he became assistant to Prof. W. G. Fearnsides at Sheffield University, and in 1921 joined Prof. P. G. H. Boswell at the University of Liverpool. At the end of 1924 he was appointed by the British Cast Iron Research Association to work under the general supervision of Mr. W. J. Rees, B.Sc., F.I.C., in the Department of Refractory Materials at the Sheffield University, and to carry out investigations on moulding sands and other refractory materials. The early years of his work were spent in evolving methods of testing moulding sands, which methods are described in the Association's Research Report No. 73. After receiving his Bachelor's Degree with Honours, Dr. Skerl proceeded to M.Sc. (London) as a result of work on the Midland-area ironstones. He received a Royal Society's grant for investigations on Midland sands, and in the middle of last year the degree of D.Sc. (London) was granted to him for work on moulding sands. Dr. Skerl is a Fellow of the Geological Society of London; a member of the Institute of British Foundrymen, and of its Sands and Refractories Sub-Committee; a member of the American Foundrymen's Association; and a committee member of the British Engineering Standards Association. He is author of numerous scientific and technical Papers and reports.

Properties of Typical Sand Deposits.

The next portion of the moulding-sand research programme of the B.C.I.R.A. has been the investigation of the fundamental properties of sands typical of those used in the chief ironfounding districts of Great Britain. It is with the results of this examination of raw new sands that the author is permitted to deal in this Paper, together with some of their applications to actual foundry practice.

The sands chosen and the districts in which they or similar sands are largely used are as follow:—

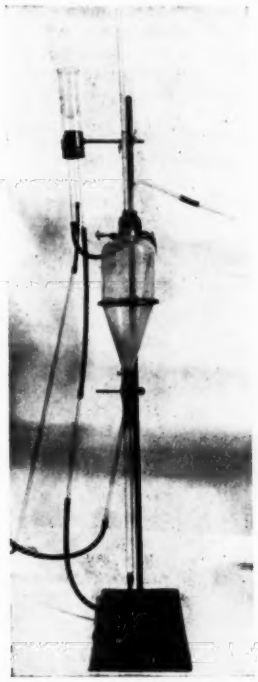


FIG. 1.—ELUTRIATOR.

Kingswinford and Bromsgrove.—These sands are typical of the red Bunter sands which are the moulding sands used in the Midlands, Lancashire, Yorkshire, etc. Similar sands are those of Birmingham, Mansfield, Worksop, Hensall, Manchester, Ormskirk and Belfast. Samples were taken from various levels in each of these quarries in order to estimate the probable extreme variation in properties in the output from each.

Erith Sand.—This sand came from Parish's pit at Erith, and each of the five grades of loam, Mild, Yellow, Medium, Strong and Extra Strong, were examined. This sand is used in the London area, the North-East Coast and in the Falkirk district of Scotland.

Southampton Sand.—Two quarries were sampled. This sand is similar to Erith sand, and is used in the southern counties and in South Wales.

Scottish Rotten Rock Sands.—This material, which is obtained by the crushing of a rotten sandstone, is the chief Scottish moulding sand. The samples taken were from the Avenuehead, Greenfoot and Loudoun quarries.

* Paper read before the Birmingham Convention of the Institute of British Foundrymen.

Pickering Sand.—This sand, from North Yorkshire, is becoming more used on the North-East Coast.

Other sands have been or are under examination, but they are all similar to one or other of the above sands.

Properties Investigated.

The following properties have been investigated in the sands: (*a*) Petrographical, mineralogical and mechanical constitution; (*b*) strength, both in the green-sand condition and after drying, at different moisture contents and amounts of ramming; (*c*) permeability, both in the green-sand condition and sometimes after drying, at different moisture contents and amounts of ramming; (*d*) chemical analyses, of the bulk sample, and the separated grades, such as clay binding material, silt, sand, etc.; (*e*) refractoriness tests, on the bulk sample, to discover the fusion range of the sand. Tests were also made at predetermined temperatures below the fusion point, whilst the refractoriness of the bonding material was also determined; (*f*) the expansion or contraction during drying at different moisture percentages and degrees of ramming; (*g*) the effect of milling on the properties of strength and permeability, and (*h*) testing of the surface given by the raw sands in both green-sand and dry-sand moulds under standardised conditions, with moulds of different sections and weights.

Possibilities of Standardising Facing Sand.

The consideration of the results of all these tests cannot be given in a Paper such as this on account of the space required, and the matter dealt with herein is confined to some of the work on new sands which has led to conclusions found to be of direct assistance to foundry-sand practice. Actual examples are given wherever possible. The B.C.I.R.A. is now engaged on the examination of actual foundry facing mixtures. Groups of ironfounders in each of the districts have been taken, each foundry using the same or similar new sand, but making different types of castings. The facing sand from each of these foundries is being examined. In this way data are being obtained which will be correlated with the properties of the new sand in order that the efficiency of the sand may be determined, and also, it is hoped, lead to the possibility that, just as specifications can be given for the metal in a mould, it will be possible to give a similar specification for the properties of the facings of which the mould is made. The results to date show the feasibility of the scheme, and that possibly in a few years' time the term "cylinder facing" will have a similar significance to foundrymen as "cylinder iron." The author would emphasise that the present Paper deals only with the results obtained in the examination of the new sands and some applications of them to foundry practice. It is not concerned with the results of research work on actual foundry mixtures as outlined above.

Ramming and the Human Element.

The proper use of his ramming tools forms a very large proportion of the art of the moulder, for the extent to which the moulding sand is consolidated in a mould has an important influence on the resultant casting. When moulds are made in a foundry by a man who has little or no control over the ramming, as on machine moulding, he is not classed as a skilled moulder, but as a superior labourer, and is paid as such. Loosely-rammed sand will cause a dirty and overweight casting due to lack of strength at the face of the mould, whilst if the sand is too heavily rammed, scabs, blow-holes, etc., may occur due to lack of permeability in the sand. The skilled moulder learns by experience the amount of ramming which is the compromise to give the sand freedom from these two troubles. On particular jobs he has to risk the openness of his sand for the greater strength that heavier ramming will give him and *vice versa*. He may have to ram hard at a particular part of the mould in order to obtain a strong face which will resist the cutting action of the metal, which will be most severe at that point. Knowing that this hard ramming may lead to blow-hole defects or scabbing, he will make greater use of his vent wire or other aids to help him improve the venting at the danger point.

All moulders do not ram to the same consistency, a point which is well brought out in a little experiment carried out in a foundry. Four moulders who were known to have been trained in different types of foundries were asked to ram up the same box from the same pattern in the same sand. The moulds were weighed and the weight of the sand in them obtained. The

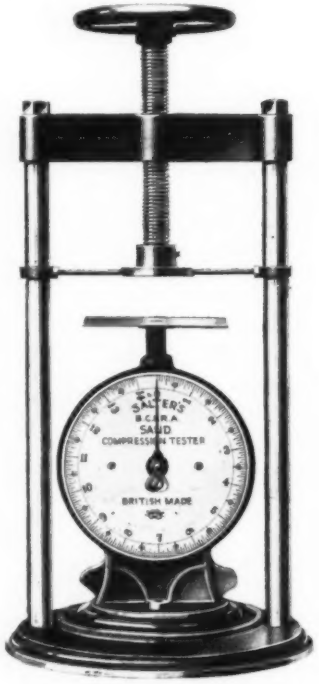


FIG. 2.—B.C.I.R.A. GREEN-SAND COMPRESSION APPARATUS.

volume of the box and of the pattern were known, and from this the volume of the sand was obtained. By dividing the weight of the sand by the volume of the sand the apparent density was obtained, this figure yielding a figure which is representative of the ramming the sand had received in the moulding box.

The following results were obtained:—

Type of training.	Weight of mould.	Apparent density of mould.
Light steel foundry ..	44 lbs.	1.84
Medium iron ,, ..	42¼ ,,	1.78
Ingot mould ,, ..	41 ,,	1.71
Light core maker ..	42 ,,	1.78

Corresponding with these variations in ramming there were differences in the surface and weight of the castings as produced by each moulder. From a large number of observations on the castings it was found that the best surface was produced from the moulds made by the medium-weight moulder and the core maker, whilst the lightest castings were made by the steel moulder. The type and place of training that a moulder receives has an important influence on his methods, and it seems certain that the "feel" of the sand which he obtains when ramming causes him automatically and normally to use one strength of blow. This strength of blow persists even if he leaves the foundry of his training, and until he has discovered the proper "feel" may lead him into difficulties in other foundries which use different types of sand which require more or less ramming.

Influence of Training.

A noteworthy example of this may be quoted. In the Birmingham district, in an area where the variety and cheapness of moulding sands is the envy of most other districts in Great Britain, there is a foundry which has to stock Erith sand, and under lock and key. This foundry is making castings in competition with other firms using the local sands under similar conditions. The moulders, however, have nearly all come from another ironfounding area. They have been trained on the fine-grained Erith mixtures, and until they have fully understood that the coarse sands from the Midlands require harder ramming to produce a good finish to the casting, the management is forced to dole out the expensive Erith sand to help them.

The question of ramming is of great importance to those in charge of a shop making similar castings on the bench and on machines. It is invariably found that the machine will ram a mould harder than the moulder, with the result that a weaker facing can be used than on the bench. This machine facing sand is too weak for the bench moulder unless he takes greater care and rams harder, thus slowing-down his production, so that he has to use a stronger mixture if his production is to be an economic one. Similarly, the use of "bench" mixtures on machines is generally unsuccessful because the machine consolidates the mould to such a degree that scabbing or other troubles are frequent. Thus for hard ramming weak sand must be used, and for looser ramming, strong sand is essential.

From the foregoing it should be obvious that any methods for the testing of moulding sands, especially for strength and permeability, should be flexible enough to permit of variation in the amount of ramming to which the test-pieces are subjected. Many methods for the testing of moulding sands use a constant ramming, generally by dropping a known weight a standard distance a definite number of times on the sand to be consolidated in a core box. This method may be useful for the control of the ramming of a single mixture, but it does not allow the adequate comparison between different mixtures or sands, especially under practical conditions. To take an extreme case, but one which is sometimes encountered in a foundry and illustrated above, if a moulder used to the relatively coarse moulding sands of a steel foundry exerted the same degree of ramming in ft.-lbs. (known weight (rammer) × height × number of blows) on a fine-grained Erith mixture, the percentage of good castings which he made in the latter would be negligible. In such districts as Sheffield, where there is an ebb and flow in good times of moulders between iron and steel foundries, these differences are appreciated.

True and Apparent Density.

In view of these and other facts, the B.C.I.R.A. has decided that a knowledge of the degree to which a sand is rammed in the foundry in practical use, or under test in the foreman's office or laboratory, is essential to the proper understanding of its properties. Ramming is part of the moulder's art, and as such is difficult of expression. Following P. G. H. Boswell and A. Rhydderch, it was decided that the apparent density of a mould or test-piece expresses the degree of consolidation of the sand. The apparent density of a core, test-piece or mould is obtained by dividing its weight in grammes by its volume in cubic centimetres. The greater the ramming the greater the amount of sand consolidated within a given volume, and therefore the greater the apparent density. The true density of the sand is much greater than

the apparent density, because the volume of sand contains a large percentage of voids which are not considered in the estimation of true density or specific gravity. It follows that the true density is not affected by ramming.

Milling.

Much research work on moulding sands has been carried out on natural moulding sands as received in the foundry, regardless of the fact that it is unusual for sand to be used for moulding purposes without some preliminary preparation by mixing, milling, addition of water, manure, etc. This preparation affects the properties of the sand, as it breaks up the pellets of clay and lumps of sand, distributes the bonding material more evenly, rendering the sand stronger, and generally improves its characteristics.

Apart from the desirability of obtaining the sand undergoing test in a condition comparable with that of its use in the average foundry, it is the experience of the author that consistent results cannot be obtained on an unmilled sand. For example, the mixing of sand and water in order to obtain a sand with a definite moisture content is slow when carried out by hand, and during the process the sand receives a certain amount of preparation by the fingers. Repeat tests made on samples prepared in this manner frequently give discordant results due to the variation in the amount of this preparation. To obtain consistent results it is essential that the new sand should be milled until its properties are constant. It is found that at least ten minutes are required to mill adequately most new sands in order to develop their best characteristics, and in some cases a longer period is necessary. The effect of milling on the properties of moulding sands wili be discussed under each of the properties examined.

Moisture Content.

The moisture content in all the experiments which have led up to the results given in this Paper have been determined by finding the percentage loss in weight of a sample of the moist sand on drying, to constant weight at a temperature of 105 deg. C. This method is, perhaps, tedious, but it is accurate. Electrical and other methods have been tried in order to discover a more rapid method for foundry control tests, but the degree of accuracy has not been sufficient to warrant their acceptance. It is hoped, however, to give a method for this purpose in the forthcoming re-issue of Research Report 73, on "Methods of Testing of Foundry Moulding Sands."

Drying.

There is an appalling lack of data on the drying of moulding sands, loams and facings, and it is a matter upon which much must be done in order to improve the efficiency of dry-sand and loam moulding. In the absence of reliable data, the temperature of 200 deg. C. (400 deg. F.) has been taken as representing an average practical drying temperature.

The Mechanical Constitution of a Moulding Sand.

The mechanical constitution is the most important factor in rendering a sand suitable or unsuitable for moulding purposes, since it controls the strength and the permeability of the sand. The mechanical analysis of a moulding sand sorts the various grains into various grades, according to their coarseness, from the extremely-fine or even colloidal material of a clay-like nature which forms the bonding material of the sand to the coarse, gravelly material which is sometimes present. These mechanical analyses, with varying degrees of accuracy, can be carried out by sieving methods, sedimentation methods, such as that developed by J. E. Fletcher, or by the elutriation process. Unfortunately, the sieving process, by whatever means it is carried out, is unsuitable for moulding sands, because it is impossible to separate the very-fine-grained material, less than 0.0004 in. in particle diameter, which contains the bond of moulding sands, or even the coarser silt particles, which, although useless as a bond, have a harmful effect on the permeability and refractoriness of the sand. Sieving methods would have to consider all material below a certain grain diameter as clay or bonding material, whereas the more accurate method of elutriation shows that in the case of fine-grained sands, such as Erith, a half of this material would in reality be silt of no binding power. The sedimentation method is extremely useful as a foundry-control test, but the results obtained with it must depend so much on the personal element that it cannot be used for research purposes or for comparing different sands or facings unless the same operator carried out the test on both sands. The third method, the elutriation process, as developed by Prof. P. G. H. Boswell, is a very accurate process, and gives results that can readily be interpreted. Elutriation may be defined as the classification of particles according to their size by upward currents of water, and since these currents have been determined theoretically and experimentally for different sizes and kinds of particles, the elutriator (Fig. 1) consists of an apparatus through which an upward stream of water flows at a definite and constant velocity. Particles, smaller than those which are supported by the constant velocity, are carried upwards and away, those of larger size sink, leaving those of size approximating to those which are just supported by the current in a true species of suspended animation. By varying the velocity of the upward current of water, the sand or other material may be further classified according to its mechanical constitution. Further particulars of the method and apparatus are given in Prof. P. G. H. Boswell's "Memoir on Refractory Sands," and in Research Report 73 of the B.C.I.R.A. It is sufficient to state here that it is possible to classify particles from less than 0.01 mm. or 0.0004 in. dia. to 0.25 mm. or 0.01 in. dia., which covers the greatest portion of British moulding sands, by the elutriation process, with the greatest accuracy, and that particles coarser than 0.25 mm. are within the accurate range of sieves. The usual nomenclature for the classification of the grades of sand are as follow:—

Clay or bond grade	Less than 0.01 mm. dia.
Fine silt grade ..	Between 0.01 mm. and 0.05 mm. dia.
Coarse silt grade ..	Between 0.05 mm. and 0.1 mm. dia.
Fine sand grade ..	Between 0.1 mm. and 0.25 mm. dia.
Medium sand grade	Between 0.25 mm. and 0.5 mm. dia.
Coarse sand grade	Between 0.5 mm. and 1.0 mm. dia.
Very coarse sand grade	Between 1.0 mm. and 2.0 mm. dia.
Gravel grade ..	Greater than 2.0 mm. dia.

The results obtained from the mechanical analyses of the sands which were examined are given in Table I, both for the sand as received from the quarry and after milling to develop the greatest strength. The following points are emphasised in the table:—

TABLE I.—*Mechanical Analyses of Sands.*

Sand.	Clay.	Fine silt.	Coarse silt.	Fine sand.	Med'm sand.	Coarse sand.	Very coarse sand.	Per cent. clay increase.	Per cent. fine silt increase.	Per cent. total silt increase or decrease.
Southampton—										
Badenham, before milling ..	12.1	1.9	10.9	74.1	1.0	—	—	—	—	—
,, after milling ..	19.7	1.9	12.1	65.6	0.7	—	—	64	—	− 9
Westwood, before milling ..	13.1	2.8	65.3	15.3	3.5	—	—	—	—	—
,, after milling	21.9	3.8	56.5	16.3	1.5	—	—	67	36	−11
Erith—										
Mild loam, before milling ..	3.4	1.9	42.4	52.2	0.1	—	—	—	—	—
,, ,, after milling ..	9.0	7.2	35.3	48.4	0.1	—	—	194	279	− 4
Yellow loam, before milling	2.8	3.6	35.9	57.2	0.5	—	—	—	—	—
,, ,, after milling ..	8.8	4.7	32.2	54.3	—	—	—	214	31	− 7
Medium loam, before milling	6.9	9.3	54.0	29.5	0.3	—	—	—	—	—
,, ,, after milling	14.1	13.8	47.7	24.3	0.1	—	—	104	48	+13
Strong loam, before milling	16.3	19.7	59.2	4.7	0.1	—	—	—	—	—
,, ,, after milling ..	20.5	21.2	57.9	0.4	—	—	—	26	7	+ 0.2
Extra strong loam, before milling	14.6	14.7	70.4	10.2	0.1	—	—	—	—	—
,, ,, ,, after milling	16.9	11.3	69.6	2.2	—	—	—	16	131	+ 7
Pickering—										
Before milling	11.7	9.0	8.8	69.8	0.6	0.1	—	—	—	—
After milling	17.3	5.3	7.7	69.6	0.1	—	—	48	− 41	−28
Bromsgrove—										
Top bed, before milling ..	5.6	1.3	8.5	66.8	17.8	—	—	—	—	—
,, after milling ..	6.3	4.1	10.9	66.1	12.6	—	—	12	216	+56
Middle bed, before milling ..	4.8	1.7	10.7	72.8	10.0	—	—	—	—	—
,, ,, after milling ..	7.3	4.7	13.2	67.4	7.4	—	—	52	176	+44
Bottom bed, before milling	5.9	2.9	15.2	70.9	5.1	—	—	—	—	—
,, ,, after milling ..	9.2	6.3	16.8	65.1	2.6	—	—	56	117	+27
Kingswinford—										
Top bed, before milling ..	5.6	3.9	19.8	68.5	2.2	—	—	—	—	—
,, after milling ..	8.9	7.2	24.1	58.2	1.6	—	—	59	85	+32
Middle bed, before milling ..	5.0	5.3	23.6	64.4	1.7	—	—	—	—	—
,, ,, after milling ..	13.2	6.6	26.3	58.3	0.1	—	—	164	24	+14
Bottom bed, before milling	5.0	4.9	17.5	67.5	5.1	—	—	—	—	—
,, ,, after milling ..	11.8	7.3	21.0	57.6	3.3	—	—	136	49	+76
Scotland—										
Avenuehead, before milling	13.3	7.1	6.4	44.0	11.4	4.1	13.7	—	—	—
,, after milling ..	15.7	6.5	5.6	47.6	14.8	4.3	5.5	18	− 8	− 0.3
Greenfoot, before milling ..	14.6	4.8	5.7	29.0	28.8	4.2	12.9	—	—	—
,, after milling ..	21.8	3.6	5.6	32.1	29.1	2.5	5.3	49	− 25	−12
Loudoun, before milling ..	18.3	5.8	6.3	32.1	30.5	3.6	3.4	—	—	—
,, after milling ..	20.2	4.3	6.1	31.6	31.4	4.7	1.7	10	− 26	−14

(1) A moulding sand consists of a mixture of grade sizes, but of these one or, at the most, two, predominate. The predominating grade is never the clay grade, for then the material would be a clay and not a moulding sand. The predominant grade determines the fineness or coarseness of the sand.

(2) The amount of clay grade is never very large and varies with the sand. As seen in the

Erith results, the percentage of clay roughly determines the nomenclature of the sands.

(3) The percentage of silt grades is low except in those sands in which the coarse silt is the predominant grade in the sand. The fine silt grade is invariably present in less proportion than the clay grade and the coarse silt grade. The percentage of silt present in the sand has an important influence on the permeability of the moulding sand, as will be seen later.

(4) Milling increases the percentage of clay grade or bond in the sand. In the new sand the clay exists in several forms, such as the ideal condition of a thin pellicle surrounding all or part of the sand grain, as lumps of clay material between the grains of sand, or as coarse aggregates with the silt or sand. These lumps and aggregates would not be thoroughly disintegrated in the process of elutriation, but would be in the process of milling, for at least ten minutes, which the sample undergoes. The milled sample would therefore on elutriation yield a higher clay grade percentage than the unmilled sample of the sand. The increases in the percentage of clay bond on milling for each sample are shown in Table I, and it will be seen that the percentage increase varies greatly from 10 per cent. to 214 per cent. There does not seem to be any general law to govern the amount of this percentage increase, but it would seem that the increase is greatest in the sands which have the least percentage of clay grade in the unmilled state, and *vice versa*. This is well seen in the case of the Erith sands. The amount of the increase would also seem to be related with the question of the quantity of bonding material necessary to coat the sand grain in order to develop the best strength properties in the sand. This coat would act as a cushion between the grains and hinder the breaking up of the excess lumps of bonding material. Therefore a sand containing an excess of clay when milled will not show such a high percentage increase in the clay grade compared with the amount in the unmilled sand. The optimum percentage of clay grade in a sand will vary with the surface area of the sand grains, which is controlled by the size of the grains.

(5) There is a wide variation in the effect of milling on the percentage of fine silt in the sands, from an increase of 279 per cent. to a decrease of 41 per cent., the decreases being found in the sands which have been mechanically treated at the quarries. The variations in the percentage of coarse silt caused by milling are small, and the percentage variations of the total silt grade are also slight, reaching a maximum of 56 per cent. in the red Bunter sands. This small variation in the silt percentage should not result in any serious alteration in the permeability of the sands. As will be shown in the section of this Paper discussing the permeability, the percentage of silt grade has the greatest effect on the permeability of the sand. This is also the reason for the emphasis laid on the necessity for light as opposed to heavy rollers in the edge runner mills used in the foundry. Heavy rollers will crush the sand grains forming silt, which will decrease the permeability of the sand.

(6) The percentage of the coarser grades of sand are reduced by milling, showing that the increase in the clay and other finer grades is due to the breaking-down of compound grains or aggregates which are rigid enough to withstand the elutriation process.

A knowledge of the grading of a sand is of the greatest help in evaluating the foundry possibilities of a new sand or as the control of facing mixtures. This is because, as will be seen later, the percentage of clay roughly determines the strength of the sand, and the percentage of silt or sand grades the permeability. If the author was placed in such a position that he had to control the facings of a foundry and it was only possible to have one piece of apparatus, an elutriator would be chosen. Under normal conditions the mechanical analysis of a facing sand is an effective index of the constancy or otherwise of the chief properties of the sand, and the differences can be correlated. Unfortunately it is a fact that glass apparatus is not ideal for the actual foundry premises and would require special protection! It is noteworthy that those foundries which have to undertake rigid control of their facings, and have reaped the benefit, have installed elutriators to control the bond content as well as running strength and permeability tests.

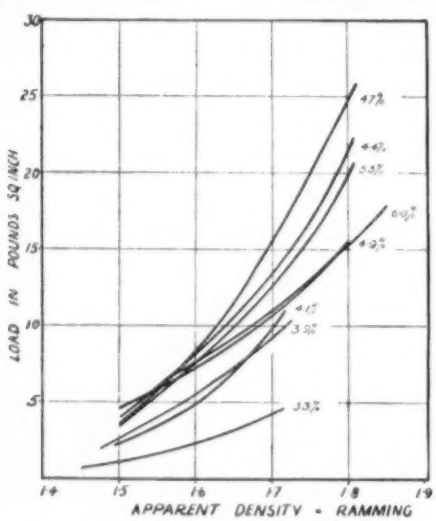


Fig. 3.—Relation between Green-Sand Strength and Ramming. Kingswinford Sand, Top Bed.

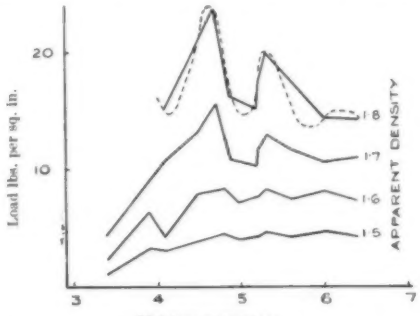


Fig. 4.—Relation between Green-Sand Strength, Ramming and Moisture Content. Kingswinford Sand, Top Bed.

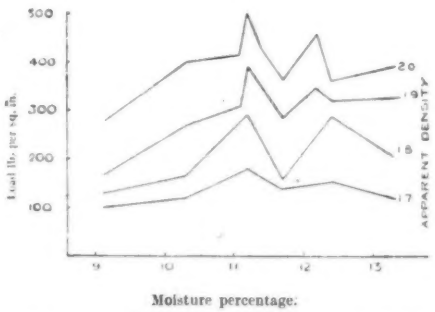


Fig. 5.—Relation between Dry-Sand Strength, Ramming and Moisture Content (before Drying). Kingswinford Sand, Top Bed.

The Strength of a Moulding Sand.

The most important property of a moulding sand from the practical standpoint is its ability under certain conditions of treatment, such as ramming, drying, etc., to retain any shape into which it is fashioned both during the preparation of the mould and the pouring and freezing of molten metal in it. This property may be described as the strength of the sand, and is the only one which is tested in the foundry albeit by the simple method of squeezing the material in the hand and breaking the resultant core with the fingers. Such a method is empirical, and relying, as it does, solely on the personal experience of the tester, cannot be accurately defined or used as a comparative test.

For research and control purposes the strength of a moulding sand may be tested by the following methods: (*a*) *Transverse test*—by applying a central load to a core suspended between two supports; (*b*) *compression test*—by loading a core of sand until it collapses; (*c*) *overhang test*—by measuring the weight or length of a piece of sand which breaks from a test core which is slowly pushed over the sharp edge of a glass or similar plate; (*d*) *tensile test*—by applying tension to a core until it breaks, and (*e*) *shear test*—by applying torsion to a core until it breaks.

The tensile and shear tests are difficult to carry out on such a generally weak material as a moulding sand, especially in the green state. The three other methods have been used during the researches of the B.C.I.R.A. and have been reported in detail in Research Report 73. It has been found that the compression test is the simplest and most rapid both for green-sand and dry-sand tests of the three other methods and is therefore now being used exclusively. The apparatus required is a core box to give cylindrical cores 1 sq. in. in cross-sectional area (1.128 in. dia.) and 2.256 in. in height, thereby following the ratio in general practice in compression testing in the diameter and height of the test-pieces. The green-sand cores are compressed in the apparatus shown in Fig. 2, which consists of a spring balance, on the pan of which the core is placed. The load is evenly applied by the handwheel and read directly in lbs. per sq. in. on the scale of the balance. For dry-sand and oil-sand core-testing the testing machine must naturally have a much bigger range.

The research test-method is as follows. The core-box is evenly rammed with the tempered and milled sand of known moisture content, the core-box removed, and the core weighed, so that the apparent density or degree of ramming can be obtained as mentioned in the paragraph on ramming, by dividing the weight by the volume of the core. The core is then placed directly in the compression apparatus if the test is on green sand, but into the drying stove if it is to be tested as dry sand. The test is repeated, using the same sand but with cores which are rammed lighter or heavier, so that a series of results are obtained on the sand at a known moisture content, but with variation in the ramming, which can be plotted as a curve on a graph showing the relation between the ramming and the strength, as Fig. 3. From a number of such curves of tests carried out on the same sand but with differing moisture contents a composite graph can be drawn, as in Fig. 4, which shows the relation between the strength of Kingswinford moulding sand, the moisture content, and the degree to which the sand is rammed.

The following points are of interest from Figs. 3 and 4: (1) The strength of a moulding sand is largely controlled by the degree to which it is rammed. The harder it is rammed the stronger it will be, and (2) the strength of a moulding sand is partly controlled by the moisture content. The sand has little or no strength with only small amounts of water, but by increasing the moisture content the strength is increased until a percentage is reached at which the sand is strongest. Further addition of water results in a decrease in the strength of the sand.

Every moulding sand, therefore, has a moisture content at which it is strongest in the green-sand condition.

If a sand be dried at normal temperatures after it is made into a core it is found that the strength of the core is greater than when in the green-sand condition. The research work of the B.C.I.R.A. on this point has shown that the moisture content of a moulding sand which gives the strongest sand in the green condition is not that which gives the strongest dry sand, and that it is necessary to add considerably more water, depending on the type and character of the sand, in order to develop this desirable condition. For example, with the Top Bed sand in the Kingswinford quarry, it is found that the sand is strongest, as shown in Fig. 4, with a moisture content of 4.6 per cent. Fig. 5 shows that to obtain the greatest strength after drying at 200 deg. C. a moisture content of 11.2 per cent. is required. Moisture contents below or above this figure yield weaker dry-sand cores.

A study of Table II, which gives the results of the strength tests on all the sands, shows that this large increase of 9.6 per cent. in the moisture content to obtain this greater dry-sand strength is not necessary for all types of sand. For example, only a smaller addition of water than that which gives the strongest green-sand cores with Scottish rotten rock sands, is sufficient to yield the strongest sand after drying. The author believes that this difference in the behaviour of different sands is due to the variation in the composition and properties of the bonding material in the sands. That this is probably the case is borne out by the fact that the moisture contents which give either the best green or the best dry strengths to the sands are not proportional to the percentage of clay bonding material in the sand, except in those cases where the bonding material is similar in character. For example, the moisture contents required to give the strongest green and dry-sand cores for the Erith sands, and for the Bromsgrove and Kingswinford sands are in each case roughly proportional to the amount of bonding material present in each sand of these groups. The slight differences may be correlated with the variation in the mechanical constitution of the sands, as shown in Table I, a coarser sand requiring less bonding material than a finer sand because of its smaller surface area.

The ratio between the greatest strengths of a sand when green and when dried at the moisture contents at which the sands are respectively strongest, varies between 14 and 36, the lower figure being present when the percentage of clay present is greatest. This tends to show that excessive clay in a dry sand may result in a weakening of the structure due to the excessive shrinkage of the clay on drying. This excessive shrinkage is often seen in loam moulds and cores.

Table II also shows the percentage of clay in the milled sand, and how dependent the strength of the moulding sand is on the clay or bond content. Nevertheless, there is no universal relationship between the percentage of clay grade and strength. For example, Loudoun Sand and Erith Strong Loam have similar clay bond percentages, yet the latter is twice as strong as the Scotch sand, whilst the Westwood sample of Southampton sand with 21.9 per cent. of bond is slightly weaker than the Bromsgrove sand with only 9.2 per cent. This is largely due to the differences in the character of the bonding material and to the variation in grading. Little is known of the properties of the bonding material in moulding sands, knowledge which is essential if synthetic sands are to be produced yielding an equivalent surface to the casting to that given by natural sands. The surface area of a fine-grained sand, that is, the area of the surface of the grains, is much greater than the surface area of a similar volume of a coarse sand, so that a larger amount of bonding material is required to cover the grains of a fine-grained sand. Therefore a coarse facing sand always contains less bonding material than a fine-grained facing sand. The B.C.I.R.A., in the examination of foundry facing mixtures, has obtained a large amount of data relative to the amount of bonding material necessary in different types of sands to render them satisfactory for different types of castings.

Before discussing the more practical aspects of the strength of moulding sands, some mention may be made of the usefulness of the B.C.I.R.A. test methods for foundry control tests on facing sands, etc. The importance of ramming has been shown to be paramount, and cannot be lightly dismissed in any form of testing that seeks to represent the moulding practice of the foundry in which the facing sands are used. It is unlikely that the average foundry will be able to carry out a range of rammings, and it is suggested that for each mixture a standard ramming be ascertained. This can readily be obtained, as mentioned above, by weighing a box, having it rammed up from a simple pattern of known volume, and weighed again. By subtracting the weight of the box from the weight of the box and mould, the weight of the sand can be found. The volume of the sand is that of the box less that of the pattern. The ramming density is then readily calculated by dividing the weight of the sand in grammes (pounds × 454) by its volume in cubic centimetres (cub. in. × 16.36). From a number of such moulds made by different moulders an average figure for the apparent density or degree of ramming can be ascertained and used as a basis for the foundry control tests.

The methods adopted and used by Mr. W. Y. Buchanan, metallurgist to the Mirrlees Watson Company, Limited, of Glasgow, for the speeding-up of the strength test are interesting. He has standardised the ramming density of the facing sands to be tested, and, therefore, uses a known weight of the sand for the making of each core. By using a core box 6 in. longer than that required to give the required core, he is able to put the known weight of sand into the box, and by the ingenious use of the hand-wheel on the B.C.I.R.A. compression apparatus, is able to apply pressure to a 6-in. plunger in the core box to give cores of correct size, which will be made under constant ramming conditions. The cores are then broken in the B.C.I.R.A. apparatus in the usual manner.

As is well known, the strength of moulding sands is increased by milling, but the extent to which it can be improved by efficient milling is hardly realised by the foundryman. The increase in strength of a new sand is economically important, because it allows the use of a greater proportion of old floor sand, in order to develop the requisite bond desired in the facing by the moulder. A. Rhydderch, F. Hudson and others have given figures showing the great increase in the strength of new sands on treatment, and have compared the efficiency of different types of mixers. The author could quote numerous examples of the value of efficient milling in producing better facing sands, using very greatly reduced amounts of new sand, but one or two examples will suffice.

In one foundry, up to recently, the green-sand facing mixture used was 4 barrows floor sand, ¾ barrow new sand and 4 shovels of coal dust. This was mixed by shovel, and it was necessary to do much sprigging and nailing on several types of mould. The amount of new sand was halved and the mixture milled in an old mortar mill, with very heavy rollers, generally used for the crushing of firebrick in the preparation of a special loam, but which was modified by raising the rollers. The resultant mixture was strong enough to make the castings, mentioned above, without the use of sprigs and nails, and output was thereby accelerated.

The examination of the strength of the two mixtures was carried out by the B.C.I.R.A. method for both sands, and the strength results for both sands, at the moisture contents at which they developed their greatest strengths, were as follow:—

	Mixed. 7.2 per cent. water.	Milled. 7.0 per cent. water.
Ramming density.	Load in lbs./sq. in.	Load in lbs./per sq. in.
1.6	3.8	8.0
1.7	11.4	16.0
1.8	19.2	23.4

It should also be stated that the permeability of the milled sand is much better than the mixed sand.

Before leaving this example of the benefits of milling, attention should be drawn to the proportion of old and new sand in the mixture. Most foundrymen would consider a ratio of 5:1 for castings weighing approxiately one hundred-

(*Continued on page* 58.)

TABLE II.—*Results of Strength Tests in Sands.*

Sand.	Clay, per cent.	Green Sand.				Dry Sand.				Ratio, dry sand to green sand.
		Moisture, per cent.	Ramming density.	Grams per sq. cm.	Lbs. per sq. in.	Moisture, per cent.	Ramming density.	Grams per sq. cm.	Lbs. per sq. in.	
Southampton—Badenham	19.7	5.5	1.7	1,640	23.4	12.4	1.9	29,510	420	18.0
„ Westwood	21.9	6.4	1.6	1,270	18.1	12.7	1.9 (1.8)	32,240	458 (321)	25.4 (17.7)
Erith—Mild Loam	9.0	3.4	1.6	1,334	19.0	9.2	1.8	38,000	543	28.6
„ Yellow Loam ..	8.8	3.6	1.6	1,161	16.6	10.15	1.8	40,500	580	34.9
„ Medium Loam ..	14.1	4.85	1.6	2,404	34.3	12.1	1.8	48,000	686	20.0
„ Strong Loam ..	20.5	6.85	1.6	2,812	40.2	12.7	1.9 (1.8)	78,500	1,120 (800)	27.8 (20.6)
„ Extra Strong Loam	16.9	5.65	1.6	2,966	42.4	13.6	1.9 (1.8)	65,500	936 (700)	22.8 (16.8)
Pickering	17.3	6.8	1.8	1,900	27.0	9.8	2.0	47,000	668	24.7
Bromsgrove—Top Bed ..	6.3	3.6	1.8	960	13.7	10.2	2.0	35,500	500	36.4
„ Middle Bed	7.3	3.7	1.8	920	13.1	10.7	2.0	33,000	471	35.8
„ Bottom Bed	9.2	4.3	1.8	1,300	18.6	11.7	2.0	35,000	500	27.0
Kingswinford—Top Bed ..	8.9	4.6	1.8	1,680	24.0	11.2	2.0	35,800	512	21.3
„ Middle Bed	13.2	5.1	1.8	1,570	22.4	11.3	2.0	36,500	522	23.3
„ Bottom Bed	11.8	5.3	1.8	1,370	19.6	11.3	2.0	38,000	544	27.7
Scottish—Avenuehead ..	15.7	5.7	2.0	1,575	21.9	8.1	2.1	39,250	560	25.6
„ Greenfoot ..	21.8	7.25	2.0	2,125	29.5	8.5	2.1	31,625	450	14.8
„ Loudoun ..	20.2	5.8	2.0	1,375	19.4	7.6	2.2	22,500	320	16.5

Cheap Melting.

THE MERITS OF MODERN CRUCIBLE FURNACES.

By G. S. Watson.

The availability to-day of enormous supplies of cheap fuel oil has led to the reawakening of interest in furnaces fired by this means, and users of the various types of coke- or gas-fired units are very naturally asking themselves whether economies cannot be effected by the adoption of oil firing. Without question, progress has lately been made in the designs of both crucible and open-flame furnaces using this fuel, and there are several convenient and attractive types of both kinds now on the market.

Quality.

The foundry manager's first care is the production of castings of a quality sufficiently high to satisfy his customers and to ensure the continuance of their orders. Subject to this requirement, he must produce castings by the cheapest methods available, so as to enable him to quote attractive prices. This article is intended to help the foundryman to decide whether crucible or open-flame furnaces should give him the results he seeks.

On the quality question, no one with any knowledge of the first principles of chemistry and metallurgy will deny that purer metal will be produced from a crucible furnace, in which the charge can be melted with as much protection from contact with flame and furnace products as the nature of the work demands. Nevertheless, there are many cases where metal melted in a modern open-flame furnace is good enough for the job on hand, though for castings of awkward design, with a low factor of safety, great care must be exercised in controlling the melting operation to ensure the minimum amount of oxidation and absorption of gases (the risk of which is inherent in this type of melting unit).

Relative Melting Costs.

The question of the relative cost of melting in the two types of furnace is by no means so straightforward an issue. Taking a superficial view, a founder will say: "I shall save my crucible bill, and if I melt my charge in the direct flame it must take less fuel and time than are required when the heat has to pass through a crucible wall." His first point is perfectly correct, but has he asked himself at what cost he will save his crucible bill? The loss of metal during melting is but seldom determined save annually, when the weight of castings produced is compared with the weight of metal bought, but careful tests have shown that when melting in open-flame furnaces the loss of metal by oxidation, volatilisation and absorption by the hearth is at least twice (and often three or four times) the amount experienced in crucible-melting practice, the losses being particularly heavy with the readily-oxidisable light alloys or with those containing zinc. A simple calculation will show that in most cases the entire saving on the crucible bill is wiped out by the value of the metal lost. Thus, a 400-lb. crucible, giving 80 heats and costing 66s., will melt 32,000 lbs., or 14 tons, of gunmetal at a cost for crucibles per ton of 4s. 8d. A generous estimate of metal loss for the class of alloy melted in crucibles is ½ per cent.

Although numerous well-organised foundries and rolling mills are able to operate with a loss well below ½ per cent., one can take this figure and translate it, with metal at 5½d. per lb., into a cost of 5s. 2d. per ton. This represents for these two items a cost of 9s. 10d. per ton of metal melted in crucibles. On the other hand, it is only by the exercise of extreme care that the loss of gunmetal in the best of the open-flame furnaces can be brought as low as 1 per cent., which, in terms of money, represents a cost of 10s. 4d. per ton of metal melted. In making the comparison, nothing has been allowed for the cost of the wear and tear of open-flame furnace linings, a by no means inconsiderable item. Certain users of crucible furnaces might argue that a life of 80 heats of gunmetal is too optimistic, but they have only themselves to blame if they cannot obtain this result. The leading crucible manufacturers have succeeded in making great improvements in their product during recent years, and, except in special circumstances, lives approaching "three figures" are the rule rather than the exception in well-regulated foundries to-day.

Flexibility of Crucible Furnaces.

When working to strict specification, the exact composition of the metal poured from the furnace is of the utmost importance. A real danger exists in this respect when changing from one alloy to another in the open-flame furnace, owing to absorption of metal by the hearth. Contamination of subsequent charges of a different alloy is the inevitable result. As crucibles always pour "clean," each metal can, if necessary, consist of a different alloy with perfect safety. As a flexible melting unit the crucible furnace undoubtedly has the advantage.

Fuel Consumption.

In examining the question of fuel consumption, it is undeniable that the preliminary stage of melting in the direct flame is more rapid than is the case with crucible melting, with corresponding reduction in the fuel and time required for this part of the liquation process. But the process is not terminated with the mere liquation of the metal. It has to be given that degree of superheat, normally from 15 to 20 per cent., that will enable it to reach the moulds in a sufficiently fluid condition to run the castings. In this essential part of the process, the crucible is at a very distinct advantage, as the superheat is passed into the lower part of the containing vessel, allowing convection currents to be generated and promoting uniformity of mixing and temperature without local overheating. The reverse is the case with the open-flame furnace, where the semi-fluid bath has to be superheated by the application of flame to its upper surface. To ensure the correct average superheat in the bath of such a furnace, the top layers of metal rise, becoming overheated, while the lower layers tend to lose heat to the furnace lining and casing. In other words, the conditions under which the superheat is added to the bath are relatively inefficient, and it is due to this cause that the fuel consumption of an open-flame furnace, operated with due regard to the quality of the metal, is at least as high as that of a modern tilting crucible furnace. It is interesting to note that the consumption of oil in the latest type of high-capacity crucible furnace, melting gunmetal, is less than 9 per cent. of the metal melted, or, expressed in money, is just below 6s. per ton with oil at 65s. per ton.

It is an undoubted fact that as the result of progress in design and manufacture, the foundry manager has at his disposal to-day a range of inexpensive melting furnaces far more efficient and convenient to operate than he had formerly. Both types of furnace have their special application, and there are numerous cases when, by reason of the weight of metal required for a cast, *e.g.*, bells, propellers and other exceptionally heavy castings, or of the bulky nature of the charge, such as sheet dippings, scrap wire or turnings, a well-designed open-flame furnace is the better proposition. Enough has, perhaps, been said to show that the selection of the right type of melting unit requires most careful consideration, failing which the foundry may be saddled with a unit that will fail to give the duty expected from it.

Sands and Sand-Testing.

(*Continued from page 57.*)

weight a very good proportion even if they milled their mixtures. That this ratio could be halved, to yield a better material by milling, should suggest to foundrymen that a little experimenting with their sand practice may yield similar economic improvements. The author can state that an increase in the time of milling from 3 to 5 min. has resulted in the saving of 25 per cent. in the consumption of new sand of more than one foundry. Larger increases in the times of milling have resulted in still better results, and some foundries mill for 10 to 15 min. to obtain them, although few dry-sand or green-sand mixtures require this period of time to develop their best properties. The author has recently given a short Paper to the Institute dealing with the importance of good sand-treatment practice along the lines of efficient milling, especially to those foundries who have to pay a high price for their sand.

There is still a tendency in the foundry world to regard the various types of mechanical screens and disintegrators as plant that will get the best out of a mixture of new and old sands. They were designed primarily to screen the sand from sprigs, etc., to mix the sand and to aerate it after milling. They are fundamentally incapable of thoroughly blending the two sands and spreading the excess bonding material in the new sand throughout the old sand in order to revive it and strengthen it for further use. This can only be done in an efficient mill by the milling action of the rollers and the constant movement of the sand.

The following table gives the strength results on the same mixture, which was put through one of the more efficient of the screening devices and also through a mill which was being worked inefficiently. Alterations in the milling practice has improved the strength of the milled sand above the figures given below, but they are sufficient for the purpose in view:—

	Mixer.	Mill.
Ramming density.	Load in lbs./sq. in.	Load in lbs./sq. in.
1.5	2.8	3.6
1.6	6.1	6.9
1.7	9.4	10.5

There is approximately a 12 per cent. increase in the strength of the sand, which, as the sand from the mixer yielded a quite satisfactory facing sand, should result, for this particular type of sand, in an equivalent saving in new sand.

To sum up this section on the strength of a moulding sand, it may be stated that it is affected in practice by the following factors:—

(1) The mechanical constitution, especially the bonding material. This is governed by the type of sand, and is best controlled at the quarry; (2) the amount of bonding material present in the sand; (3) the distribution of the bonding material. This is controlled by the efficiency of the sand treatment; (4) the moisture content. This is under the control of the foundry for the facing mixtures, but only in a few cases is it thought worth while; (5) the amount of ramming. This is the moulder's skill or part of a moulding machine's efficiency; and (6) the temperature and rate of drying. Little is known regarding these factors, but too rapid or too fierce drying are detrimental to strength.

(*To be concluded.*)

Recent Foundry Developments.

The discussion on Mr. J. G. Pearce's Paper* on this subject centred round the "balanced-blast" cupola, high-silicon cast iron, and the germ theory.

It was opened by MR. A. SUTCLIFFE, who mentioned a new form of cupola upper part in which the dirt and grit was collected and the cost of lining the upper part avoided. He exhibited photographs of several cupolas on these lines in the hope that members might profit by them.

MR. E. LONGDEN, referring to the "balanced-blast" cupola, asked what was the advantage of the dish valve? It was claimed that the dish valve could be closed when it was desired to clean the front of the tuyere. One could imagine, however, that if the tuyere was opened, when blowing, the hot gases would pass through the opened tuyere just as when the slag notch was open, and the dish valve would be of no use whatever. It would appear that full control could be obtained by the manipulation of the ball valves.

MR. J. E. FLETCHER (consultant to the British Cast Iron Research Association) said there had been no trouble whatever of the kind referred to by Mr. Longden; they could use the valve and clear the tuyeres as desired, without difficulty. Cupolas of the "balanced-blast" type, of capacities within the range between 2 and 12 tons per hour, were already working; there were not many of them yet, but all of them, without exception, were operating successfully, and the expected reductions in coke consumption had been achieved. Of course, where it was necessary to melt at specially high temperatures it could not be expected that the coke consumption would be so low as when melting at ordinary temperatures, but the temperatures required by foundrymen to-day were being obtained with ease and regularity.

The Present Position of the B.C.I.R.A.

MR. J. G. PEARCE said the Paper was an attempt to indicate the main work carried out by the Association, covering, as it did, founding, and not merely cast iron itself. He had had to exclude many matters which were of interest to particular sections of the industry, and, indeed, his problem had been not so much to decide what to include in the Paper, but rather what to exclude. During the last seven years the Association had issued something like a hundred research reports, whilst other documents and reports issued must number double that figure.

Mr. Pearce took the opportunity to refer to the position of the Association, having regard to the altered basis upon which the Government would give financial support in the future. During the next few months, he said, the Association would pass through a rather critical time, and the Council was anxious that every British foundry should be acquainted with the nature of its work and the possibilities arising therefrom. There was no channel through which the founders of the country could be reached more effectively than through the Institute. The Association had commenced its work in 1921 with the aid of a Government grant equivalent to the amount of the subscriptions obtained from the trade, and it was the original intention that the Government grant should cease at the end of five years from that date, the Association becoming self-supporting. Not very much could be done within a period of five years, however, towards establishing a permanent organisation. The choice of staff, the provision of accommodation, the building-up of routine, and so on, was a very long job. Thus, at the end of the first five-year period the Association had been able to persuade the Government to continue its support on the original basis for a further three years, and, at a later date, to continue it for a further two years.

This last two-year period would expire at the end of June, 1931. The £1 for £1 basis on which the Government had assisted had meant that a subscription income from the industry, increasing from about £2,000 per annum in 1924 to nearly £5,000 per annum, had been matched by an equivalent grant from the Government. Now, however, the Association, in common with others of its kind, had to proceed on a new basis. The Government had made the very valuable concession that it would continue to grant very much what it had granted up to date for another period of 10 years at least—which probably meant indefinitely—provided the industry would raise double the amount it had raised in the past. He could not believe that the industry could not find that amount. It was a basic industry in this country, but the amounts it had contributed to the support of the Association compared very unfavourably with the amounts raised for research by such comparatively limited and small industries as those of laundries, paint and varnish, cocoa and chocolate, and so on.

Annual Value of Castings.

It was estimated that there existed in this country about four times as many production foundries which could profit by membership as there were present members of the Association, and, when one considered the possibilities of effecting savings, as demonstrated in his Paper, surely there should be no difficulty in obtaining the extra support required. When it was realised what was being done by our rivals in Germany and America, one became very apprehensive as to the technical future of the industry in this country; the Association felt that the future of the industry could be ensured satisfactorily if the extra income asked for were subscribed. The value of the products of the trade as castings was at least £40,000,000 per annum, and the subscriptions asked for represented about one-third of a penny per ton of output.

Discussing the difficulties under which the Association had laboured so far, Mr. Pearce said that it was required by the Government to spend its annual income in research. It had very little in the way of apparatus and equipment with which to do the work required, for the reason that it had not the funds with which to purchase that apparatus and equipment. When experts from abroad visited the laboratories they were rather astonished that the Association should have done what it had done with the equipment available, and those connected with the technical schools and universities were equally astonished that an industry which was frequently generous to them should have a research association comparatively unequipped. Technical colleges and universities could obtain it by the simple expedient of drawing on the rates or taxes, or both. The Association could not do that, and the industry might consider whether the time had arrived in which it should help more in this way. The present Paper should be taken as an indication of what might be done under more favourable conditions than as a record of achievement in itself.

Modern Cast Iron Shows High Strength.

Commenting upon the statements made in Mr. Pomeroy's Paper concerning the poor progress made in regard to the strength of grey iron, he said he would like to offer Mr. Pomeroy a little hope. Reference has been made in his Paper to the modulus of rupture of Watt's cast iron, and Watt's figures had been compared with the American figures as revised in 1918. Mr. Pearce pointed out, however, that the figure in the 1930 specification of the British Engineering Standards Association corresponded to a rupture modulus of 23.1 tons per sq. in., which was rather higher than the American figure, and that any buyer of castings in this country was entitled to quote that specification and to demand that strength in the product. One did not feel particularly surprised to-day when one obtained in the laboratories, from commercially-made material, transverse strengths of from 40 to 50 tons per sq. in. In his own Paper he had referred to tests which had indicated transverse tests of over 40 tons per sq. in., and in the laboratory bars had been pulled at over 50 tons per sq. in. tensile. It might be said that these were experiments, but he emphasised that the experiments of to-day were the commercial developments of to-morrow, and it was the job of researchers to incubate these things and to put them into commercial practice with the least delay. At one time it had been estimated that 25 years elapsed between certain laboratory discoveries and their complete development by industry, but the Research Association had been able in some cases to reduce that period to 18 months. Furthermore, a high-strength bar did not imply a perfect casting, a thing they always had to keep in mind.

Finally, Mr. Pearce said he would reserve comment upon the cupola mentioned by Mr. Sutcliffe until he had been able to study the photographs; also, he would be pleased to reply to any written comments upon his Paper.

Coke Ratios.

MR. HORACE J. YOUNG wrote saying that the soft-blast cupola, mentioned by the author, with a coke consumption of 10 to 1 for engine castings and 13 to 1 for light castings, would appear to be fairly normal in view of the fact that Germany seems to have standardised a coke consumption of 10 to 1 for any kind of castings. Moreover, the writer works at 10 to 1 for the highest form of Diesel casting. He knows of one old cupola, 54 in. dia., working on 8.7 of coke and another of 49 in. working on 6.2 of coke, and, so far as he knows, they have been working on these ratios for many years. We have also other patent cupolas which are spoken well of and, undoubtedly, there are many more yet to come.

High-Silicon Irons.

Regarding high-silicon irons, the writer finds difficulty in knowing whether the iron spoken of by the author is a 4 per cent. silicon iron or a 7 per cent. silicon iron. It is necessary to come to definite figures if low-silicon irons are to be compared with high-silicon ones. One must know what one is talking about. For instance, is a 4 per cent. silicon iron much superior to a 0.75 per cent. silicon iron? So far as the writer has been able to ascertain it would appear that 4 per cent. silicon iron has small advantages and large disadvantages from the practical standpoint. At the same time he is open to be corrected and is speaking merely upon what he has seen in practice.

The author states that he does not recommend high-silicon iron for engineering castings, but that it is applicable particularly to firebars, stoker links, furnace castings, melting pots, retorts, etc. In view of the fact that considerable success is being obtained with low-silicon irons for these purposes, one is particularly interested to know precisely the high-silicon iron which is better without being, at the same time, worse. This may seem absurd, but, nevertheless, it may not be so. The writer desires it to be known that he is not inimicable to the high-silicon irons or to any new material and will readily adopt anything which is better, with the proviso that it must be capable of being made cheaply and easily and must "behave itself" in the foundry, in the machine shop and in service.

Inoculated Irons.

What the author says about the germ theory and inoculated irons is exceedingly interesting. The writer spent a long time in Germany last year visiting foundry after foundry where processes were in operation which depended upon this theory or something similar. There have

* Presented at the Annual Convention of the Institute of British Foundrymen, and published in our issues of June 25 and July 9.

been mysteries in cast iron which could not be solved practically or theoretically. For instance, the writer asked a long time ago for research work to be done on the fact that an all-pearlitic cast iron containing 0.5 per cent. less graphite than another all-pearlitic cast iron of otherwise similar composition is often no stronger, if as strong. This germ theory, or what might in his opinion be better called the theory of nuclei of indissoluble free carbon existing in molten cast iron, explains many of these things. Moreover, we know now that the addition of alloys in particular carbide form gives very different results from those obtained when alloys are added in other form. On the Continent these things are being applied to practice with great benefits to all concerned, and it is within possibility that the foundries of this country will be able to benefit in similar manner. Even to-day it is possible—and the writer does it regularly—to produce cast irons of which the strength and composition and behaviour are predetermined with extreme certainty. It is done, firstly, by a long experience of the word "composition," and, secondly, by an equally long one of the word "mixing." When one studies the composition of a hematite or phosphoric pig-iron before incorporating it into a mixture it will be found that the quality of the cast iron depends upon the composition of the original hematite or phosphoric iron. Therefore, if the compositions of the original pig-irons suggest that they contain nuclei the effects will be felt in the resultant cast irons.

All these points look very difficult when put down on paper, but to any foundry metallurgist of long practical experience they are nothing like so difficult to apply to practice. The physical side of the question must be associated with the chemical one. It is unlikely that the foundryman has considered the physical side save in his ideas about fractures, which as a general rule have led him to choose an open-fractured iron with, did he but know it, disastrous results and lack of progress either in knowledge or in producing better irons.

Coke Ratios.

MR. PEARCE, in reply to Mr. Young's written contribution, said that the consumption figures for the soft-blast cupola were quoted because they were normal, but Mr. Young did not comment on the consumption figure of 5.6 per cent. obtained on the "balanced-blast" type. He was fully aware that cupolas here and there throughout the industry could be found working on extremely economical lines, and it would be expected that here and there a favourable combination of design, fuel and operating conditions would give good results. These figures, however, were no argument against their efforts to secure better coke-consumption figures in ordinary practice. The real question was whether Mr. Young would be prepared to design, for example, a 49-in. cupola and guarantee a coke-consumption figure of 6.2 per cent., like the one which he stated had been working for many years. Cases had arisen in which a new cupola in a foundry had not equalled a performance of an earlier type.

High-Silicon Irons.

With respect to the Silal irons, any irons over 4 per cent. silicon were regarded as high-silicon irons, and the precise silicon content depended upon the application. The superiority in freedom from growth and scaling of a high-silicon iron over a low-silicon iron was undoubted. Four per cent., however, was rather low unless the material was very carefully made. The remarks on the germ theory did not seem to call for comment, except that it would be unfortunate to call the theory that of "indissoluble free carbon existing in molten cast iron." The carbon was, in fact, not indissoluble, and is dissolved readily under certain conditions, and inoculation was the process of replacing graphite so dissolved. Mr. Young doubtless meant "undissolved free carbon," but the term "germ theory" was a short and convenient phrase.

Book Review.

Der Giessereischachtofen in Theorie und Praxis (Foundry Cupolas in Theory and Practice), by DR. ING. A. ACHENBACH. Published by Dr. Max Jänecke, Verlagsbuchhandlung, Hospital Strasse, Leipzig. Price 7.80 RM. plus postage.

We fear the author will not be at all pleased when he learns that we have translated his carefully-chosen word "Giessereischachtofen" (foundry shaft furnace) by the word "cupola." As is well known, the word "kupolofen." is fairly current in Germany, but the author objects to its use on historical grounds, which are untenable from the English-language point of view. He credits Wilkinson as the originator of the modern cupola, and it is rather a pity that a misprint (Wickinson) should have crept in to mar it. In fact, there are far too many mistakes of this character. For instance, Young, Bartlett, MacPherran and Dennison have all their names more or less badly mutilated.

The opening chapter deals with a few elementary considerations of receivers, spark-arresters, drop-bottoms, bricking and the like, The second covers the working of the furnace, by dealing with such subjects as the disposition of the charge, the blast, the underlying principles of melting, the zone divisions, of which the author recognises four—hearth, combustion, melting and reducing, and heating-up; melting losses and gains and chemical composition of slags.

Chapter III outlines a number of modifications, such as the Schürmann (which is criticised on the grounds of the cost of installation and amortisation being equal to any economies achieved), Corsalli, Greiner and Erpf, Poumay, Vulkan and Walter-Dürrkopp-Luyken-Rein. Modifications which are not well known in England are the Schinke, which embodies a syphon arrangement, and the Meixner, which incorporates a patented slag-trap.

Chapter IV is devoted to cupola control, with extended reference to the measurement of the blast input and temperatures. We suppose that the author has deemed it desirable in Chapter V to outline the metallurgy and metallography of the iron-carbon system so that he can develop its relationship to cupola practice. This section is distinctly sketchy, and could without detriment to the book be left out. The micros are too small and no magnifications are given.

The basic principles of cupola costing and thermal efficiency are covered in Chapter VI, whilst their practical application is outlined in Chapters VII and VIII. The 36 tables are all assembled at the end of the book, between the end of the text and the bibliography. Whilst the contents list is fairly exhaustive, we should have appreciated the inclusion of an index. As a statement of the current position of the art and science of cupola practice, viewed from the German angle, the work is one of first-rate importance.

Prize Competition for Welders.

Owing to the success attending last year's competition, The Institution of Welding Engineers has decided to offer the Gold Medal of the Institution and a prize of £10 10s. for the best Paper by a working welder on "Welding and Cutting on Railways and Tramways" for this year's competition. The Institution is desirous of affording working welders an opportunity to bring the results of their practical work on railways and tramways before their fellow members of the welding industry. The conditions attached to the competition will be sent to interested persons on application to the secretary of the Institution, 30, Red Lion Square, London, W.C.1.

Mould Dressings and "Life" of Metals.

Mr. André Courty, in the course of a research into the "life" of aluminium and some light alloys, which he has detailed in two recent issues of "Revue de Métallurgie," investigated the effect of mould-surface dressings on this property. In his experiments he used the usual method of making a spiral under controlled conditions, and measuring the length of the casting. The table set out below shows how "life" can be affected by the nature of the surface of the mould.

Surface conditions.	Length of casting in cm.
Normal	51.0
Ironed surface	49.0
Treated with a mixture of 50 per cent. glycerine and 50 per cent. water	48.0
Naphtha	51.0
Castor Oil	55.8
Linseed Oil	56.5
Treated with a mixture of boiled linseed oil, 5 per cent. soft soap and 5 per cent. quick lime	57.8
Heavy layer of iron oxide	62.0
Core paste, put on hot, made from 1,800 grms. of plumbago; rouge 600 grms., and 10 litres of water	63.4
Chill-mould paste, put on hot, made from 2,500 grms. of whiting; 400 grms. of plumbago; 10 litres of water and 200 grms. of waterglass	67.0
Acetylene lamp black	80.9

Mr. Courty is of opinion that surfaces treated with liquids like water and petrol do not lower the "life" of light alloys, because the bank of gas produced compensates, by its heat-insulating effect, the loss of heat from evaporation. Linseed oil, with or without matter in suspension, improves the "life" by its poor conductivity.

Solid dressings improve the "life" in a very distinct manner by their heat-insulating properties, the pastes detailed come into this category; and especially the lamp black, as it produces a spongy layer.

British Chemical Standard High-Duty Iron "G."

A new British Chemical Standard high-duty iron ("G") is about to be issued, the analysis of which is as follows: T.C., 2.68; Gr., 1.82; C.C., 0.86; Si, 1.30; Mn, 0.410; S, 0.125, and P, 0.45 per cent.

This sample has been made specially to meet the need for an iron low in total carbon, moderately low in phosphorus and fairly high in sulphur content. Care has been taken to prepare fine turnings free from dust to make it as homogeneous as possible, and particularly with a view to its use for the determination of total carbon and graphite. In order to prevent deterioration, the bulk of the turnings is being stored in an atmosphere of dry nitrogen.

By using British Chemical Standard irons "A," "B," "D2" and "G," either separately or in conjunction, it is now possible to have standards which cover all the usual requirements of ordinary cast iron. In accordance with the usual practice, iron "G" has been standardised by a number of chemists representing manufacturers of refined iron, makers and users of high-duty castings, and also by independent analysts. Unusually full notes on the methods of analysis used are given on the certificate of analysis issued with each bottle. Further particulars may be obtained from British Chemical Standard Headquarters, 3, Wilson Street, Middlesbrough.

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Trade Talk.

MR. J. H. HINCHLIFFE, a director of Messrs. Hopkinsons, Limited, of Huddersfield, last Saturday formally opened a new sports ground to be used for the benefit of the works sports association.

WILLIAM DENNY & BROTHERS, LIMITED, have launched from their Leven shipyard, Dumbarton, the motor-vessel "Ardenvohr." She has a carrying capacity of 9,000 tons deadweight.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, has secured from the Victoria Falls Power Company an order for a 26,000-kw. turbo-alternator. The contract is to the value of approximately £104,000.

IRON AND STEEL IMPORTS in the Tees during June totalled 13,511 tons, as against 14,490 tons in May and 10,260 in June, 1930. The amount of iron and steel imported for the first eight months of the Commissioners' year was 109,874 tons.

SIR WILLIAM ARROL & COMPANY, LIMITED, Glasgow, have secured contracts from the Ministry of Transport for the dismantling of bridges at Fort-William, Aberchalder and Laggan, on the Caledonian Canal, and replacing them by petrol-driven swing bridges.

MESSRS. H. WHITEHEAD & COMPANY, LIMITED, engineers and agents, Sentinel House, Southampton Row, London, W.C.1, have recently been appointed London agents for the Mansfield Engineering Company, Limited, the British Spun Glass & Insulation Company, Limited, Leeds, and Grill Floors, Limited, London.

MESSRS. SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, have booked an order for a passenger steamer of 5,000 tons gross for French owners, to be built at their Walker yard. An order has a so been secured for a collier for Messrs. Stephenson Clarke & Associated Companies, Limited, which will be built at their Wear yard.

THE ARGENTINE CHAMBER OF COMMERCE IN GREAT BRITAIN has changed its offices from Regent Street, London, to River Plate House, 12/13, South Place, E.C.2. Mr. W. S. Barclay, until late, general secretary of the British Empire Trade Exhibition of 1931 in Buenos Aires, has been appointed general manager of this Chamber.

THE JOINT SECRETARIES of the Board of Conciliation for the Regulation of Wages in the Pig-Iron Trade of Scotland have received intimation from the auditors that an examination of the employers' books for the three months ended June 30 shows that the average net selling price was £3 11s. 8d. The wages of the workers will be reduced by 2 per cent. on basis rates.

THE MANAGEMENT COMMITTEE of the London Iron and Steel Exchange has decided to suspend the weekly meetings at the Cannon Street Hotel during the holiday season, as representatives find it difficult to attend owing to the depletion of their staffs. No session of the Exchange, therefore, will be held after the meeting on Tuesday afternoon, July 21, until Tuesday, September 8, when the weekly meetings will be resumed.

BABCOCK & WILCOX, LIMITED, Renfrew, by securing orders worth half-a-million pounds, are now in a position to keep a full staff working until early in 1932. One contract is for boilers and all accessories for the Victoria Falls Power Station, South Africa, and is to the value of £250,000. With this goes a building order for £100,000 which will not be placed until the boiler plant has been delivered, but Messrs. Babcock & Wilcox are tendering for it. The other contract, worth £100,000, is for two boilers and equipment for the Portsmouth Corporation. During recent months the firm has booked over £1,000,000 worth of orders.

SIR HARRY MCGOWAN, in his Presidential Address to the annual meeting of the Society of Chemical Industry at the Royal Academy of Music last week, said the progress made during the 50 years' existence of the society was shown by the fact that the British Isles to-day maintained a greater population in a higher standard of comfort than in 1881. In that period the population had grown from 35,000,000 to 49,000,000, and the national income from about £1,800,000,000 to £3,600,000,000. The chemical industry's growth was even more astonishing. While the overall increase in British exports in that time was 53 per cent., the increase in British chemical exports was 94 per cent. Discoveries might appear to the chemist to be final in their achievement, but they were only the beginning of a new problem to the industrialist. It was the task of the industrialist to hold the balance between the application of discoveries and the preservation of the existing economic equilibrium. New knowledge might threaten to derange whole industries, raising social, financial and political problems. The vast number of workers in industry were slow to realise that their products were bringing in less money, and, therefore, slow to grasp that unless all costs fell proportionately with prices, business would be lost and employment reduced. Other difficulties arose from the custom of borrowing capital at fixed rates of interest. Out of smaller profits fixed interest rates took the same amount of money. Dividends were reduced, market values of shares declined, and the investor's purse was closed to new enterprise. The same difficulty in national finance, when a large proportion of the public expenditure was represented by unchanged rates of interest upon a National Debt, tended to increase the burden of taxation upon industry.

Company Meetings.

Petters, Limited.—The twenty-first annual general meeting of Petters, Limited, was held on July 14 at Yeovil, SIR ERNEST W. PETTER (the chairman) presiding. In the course of his remarks he said, with regard to the national industrial situation, that the curse of unemployment which had persisted since the war, and which was aggravated by the administration of the dole, had transformed a considerable proportion of what ought to be the working population into a parasitic growth, and there were tens of thousands of people in this country at the present moment who were content to live, or rather exist, in idleness. So far as his company was concerned, on the accounts under review the amount paid in taxation was far in excess of that which was paid in dividends to the shareholders, and even such taxation as this did not suffice, for the country was accumulating an enormous debt on the Unemployment Fund, a debt which it was quite certain would never be repaid, and to this extent even such a Budget as was presented this year was fallacious and was, in effect, unbalanced. His personal view was that industrialists, notwithstanding that they were fully occupied in endeavouring to keep the heads of the organisations with which they were connected above water, must either take a hand in affairs themselves, or this country would commit *felo de se*.

Davy Bros., Limited.—The annual meeting of Messrs. Davy Bros., Limited, was held at the Royal Victoria Hotel, Sheffield, on July 14, MR. E. J. Fox (chairman) presiding. In the course of his remarks he said that he felt that the company was possessed of two assets of outstanding commercial value—a name for its products which stood second to none in the world in the specialised lines in which it had traded, and a new works at Darnall laid out on the most modern and up-to-date lines, and available for handling orders cheaply and efficiently. The only difficulty under which the company was trading was the difficulty of obtaining sufficient orders in the specialised lines on which the business was founded. Until recently their principal customers had been the heavy steelworks, and the depressed condition of this industry had automatically been reflected in the firm's order-book. The board fully recognised the necessity of obtaining work in other directions until such time as the iron and steel works were again placed in a position of resuming purchases. And with that in view they were taking active steps towards obtaining work in directions which until recently had been looked upon as outside the direct scope of their company. In other words, it was the intention of the board to take every possible step towards obtaining work to keep the several departments occupied in preference to working, as they have been working more recently, at a comparatively small proportion of their full capacity. Their principal anxiety was to strengthen the commercial side of the business to do justice to the inside capacity of the undertaking.

Wills.

FITZBROWN, G., a director of Broughton Copper Company, Limited, Salford ...	£53,292
SAUNDERS, F. B., for many years secretary and commercial manager of the Rhymney Iron Company, Limited ...	£19,102
BURLINGHAM, CHARLES, of Evesham, of H. Burlingham & Company, Limited, agricultural engineers and merchants	£59,464
NAYLOR, JOHN WILSON, of 24, Thornsett Road, Sheffield, governing director of Steel (Sheffield), Limited, steel manufacturers, of Pagoda Works, Sheffield	£1,996

Obituary.

DR. E. G. ACHESON, probably best known for his work on abrasives and carbon electrodes, died in New York on July 6, at the age of 75.

THOMAS HENDERSON MELDRUM, a moulder employed by D. & J. Tullis, Limited, Clydebank, whilst crossing a siding was crushed between buffers and died in the Western Infirmary from internal injuries.

THE DEATH HAS OCCURRED, at the age of 74, of Mr. William Reid-Neill, M.B.E., who was well known in shipping and engineering circles, and who was formerly manager of the Sunderland Engine Works of the North Eastern Marine Engineering Company, Limited.

MR. GEORGE J. MASSEY, who was in charge of the engineering section of the Belvedere Works of Callender's Cable & Construction Company, Limited, has died at the age of 53. He was well known in the electrical industry and had been in the company's service for nearly 30 years.

MR. JAMES TODD MCCALL, president of the firm of Drummond, McCall & Company, Limited, of Montreal, died in that city on July 1 at the advanced age of 75. He was born in Glasgow, but removed to Canada in 1879. He was also a director of Canadian Ironfoundries, Limited, and several other concerns.

Contracts Open.

New Quay, Cardigan, July 29.—280 tons of 9-in., 4-in. and 3-in. cast-iron pipes, etc., for the Urban District Council. The Clerk's Office, New Quay. (Fee £3 3s., returnable.)

Ruscombe, Berks, July 25.—2,484 yds. of 3-in. cast-iron main and 660 yds. of 4-in. cast-iron pipes, etc., for the Wokingham Rural District Council. Mr. W. E. Smith, "Ailsa Craig," Crescent Drive, Maidenhead, Berks.

Singapore, August 12.—Cast-iron or steel pipes, etc., for the Singapore Municipal Water Department. The Department of Overseas Trade. (Reference G.X. 10,552.)

Southampton, September 1.—Portable electric crane, for the Town Council. Borough Engineer, 33-35, French Street, Southampton. (Fee £3 3s., returnable.)

Personal.

MR. M. R. PEASE has been appointed sales manager of Leyland Motors, Limited, to fill the vacancy caused by the death of Mr. A. W. Windsor.

MR. A. J. CAPRON has relinquished his position as managing director of Davy Brothers, Limited, Sheffield, after 30 years' service in that capacity, and retains his seat on the board.

MR. RICHARD BINDER, the president of Metals Coating Company, of America, together with Dr. Leopold Pessel, metallurgist to the company, is visiting Europe with the object of cementing relationships with kindred companies.

ON SEVERING his connection with the Glasgow Iron & Steel Company, Limited, Wishaw, Mr. Kenneth W. Seton-Carr, works manager, was presented with a gold cigarette case by officials and workmen.

MR. E. PINCKSTON, having resigned his position with Messrs. Veritys, Limited, has been appointed to take up the representation of Messrs. Laurence, Scott & Electromotors, Limited, in the Birmingham area.

Reports and Dividends.

Braithwaite & Company, Limited.—Net profit £23,634, including £10,999 in respect of a dividend declared by the Indian company, dividend on ordinary 4 per cent.; carry forward, £64,405.

A. & J. Main & Company, Limited.—Net profit for 1930 amounted to £7,183; brought forward, £5,181; available, £12,364; dividend on ordinary 2½ per cent., less tax; carry forward, £4,232.

D. & W. Henderson & Company, Limited.—Profit for year, after allowing for all charges but before providing for depreciation, was £19,777, against £17,332 the previous year. Preference dividend requires £15,000, and £3,910 is allocated to depreciation. The ordinary capital is held by Harland & Wolff.

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Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

ESTABLISHED OVER 110 YEARS.

MARTHA SIMM & SONS LTD.,

Nuns Lane Mills, GATESHEAD-on-TYNE

Manufacturers of

IRONFOUNDERS' BLACKINGS

DURHAM COAL DUST, CHARCOAL, &C.

IMPORTERS OF

FINEST CEYLON PLUMBAGO

ENQUIRIES SOLICITED

Telegraphic Address: "BLACKINGS GATESHEAD."
Telephone No.: 740 GATESHEAD.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland iron market is still abnormally quiet, and unfortunately traders appear to be resigned to the situation. Export sales have almost ceased, and merchants, deprived of this market, are undercutting the local ironmasters with Midlands iron. A lowering of the price level, inevitable as it seems, is still resisted by the Cleveland ironmasters. Hence, to all destinations except Scotland, the fixed minimum prices are still unchanged, as follow:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge iron, 57s. per ton.

The East Coast hematite market, which has been fairly stable lately, eased off somewhat this week. Stocks of iron began to accumulate, resulting in cut prices. Thus, the nominal market quotation for East Coast mixed numbers was reduced on Tuesday from 62s. 6d. to 62s., and buying for export or in large quantity could be negotiated at 6d. per ton less. These prices, however, are not regarded by the makers as established, and slightly higher prices are quoted for forward contracts. On the North-West Coast, Bessemer mixed numbers are still quoted at 66s. per ton at works.

LANCASHIRE.—The demand for pig-iron in this area is slightly better than it has been for the past three months, although the manufacturers of textile machinery still demand very little foundry iron, and, until this particular market recovers, there can be no general improvement in the consumption of pig-iron. Prices are practically the same. For delivery to users in the Manchester price zone, Staffordshire, Derbyshire and North-East Coast brands of No. 3 iron are on offer at round 67s. per ton, with Northamptonshire pig-iron at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at from about 87s. to 87s. 6d., and West Coast hematite iron at round 81s. per ton.

MIDLANDS.—The market for pig-iron is still depressed, especially in the case of heavy castings. The needs of the ironfounders are limited. For delivery to Birmingham and Black Country stations the furnaces still quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—Trade is still interrupted by the holidays. Orders are still very scarce and the Scottish ironmasters complain bitterly of the foreign competition. Scottish pig-iron makers are quoting as a fixed minimum price 71s. per ton for No. 3 foundry, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 is 52s., f.o.t. Grangemouth.

Finished Iron.

The demand for finished iron is still very limited, the best-situated mills being those dealing with marked bars and similar grades. The other mills are working only spasmodically. Quotations for crown bars still vary widely, anything from £9 5s. to £10 being quoted, with nut and bolt iron at £8 10s. to £8 12s. 6d. Staffordshire marked bars are maintained at £12. For common nut and bolt work the Continental product is being purchased, the present price delivered to Black Country works being at about £4 15s.

Steel.

The finished-steel market is still quiet, and little improvement can be expected till the autumn. The decision of the steel-makers to leave prices unaltered has caused much disappointment, especially so with regard to the serious position of the shipbuilding industry. The demand for structural steel is still poor. The market for Continental semis is very firm, and there is not much business moving. The majority of the consumers have their needs already well covered.

Scrap.

The Cleveland market has again relapsed into a state of comparative stagnation, and production far exceeds the demand. Ordinary heavy cast-iron is quoted at 42s. 6d. per ton, and good machinery quality at 44s. The Midlands market is still depressed. Heavy machinery scrap in cupola sizes is offered at 47s. 6d., and light cast-iron at 37s. 6d., both delivered. In Scotland, business in the iron and steel scrap market is completely suspended, as consumers have stopped deliveries owing to the holidays. Very few new contracts have been negotiated lately. Machinery cast-iron scrap is quoted at 48s. 6d., and heavy cast-iron scrap, suitable for foundries, at 43s. 6d., delivered at consumers' works.

Metals.

The metal markets now have the appearance of being quite disillusioned. The buoyant tone created by the Hoover war debt proposals has given place to a general feeling of dissatisfaction and uncertainty. Within a month of Mr. Hoover's momentous announcement reaction had set in and standard copper in London dropped to £33 5s. The German troubles have cast their shadow over trade generally, and last week, in view of the forthcoming London conference to deal with the German financial crisis, there was little disposition to trade.

Copper.—Conditions in this market remain discouraging. Confidence has all but disappeared, and sales are negligible. No uniform curtailment of output has been agreed upon.

Closing quotations :—

Cash.—Thursday, £33 5s. to £33 7s. 6d.; Friday, £34 17s. 6d. to £35; Monday, £34 15s. to £34 17s. 6d.; Tuesday, £34 12s. 6d. to £34 13s. 9d.; Wednesday, £34 2s. 6d. to £34 5s.

Three Months.—Thursday, £34 to £34 1s. 3d.; Friday, £35 10s. to £35 12s. 6d.; Monday, £35 10s. to £35 11s. 3d.; Tuesday, £35 7s. 6d. to £35 8s. 9d.; Wednesday, £34 17s. 6d. to £35.

Tin.—The peregrinations of Continental finance have had a predominating influence on this market, although the firmer undertone indicates that, when the present difficulties are overcome, the market, on its own merits, will be able to support a return to higher prices. In fact, if consumption maintains its present level, it may be said that the statistical position is more favourable.

Official closing prices :—

Cash.—Thursday, £108 to £108 5s.; Friday, £112 15s. to £113; Monday, £112 12s. 6d. to £112 15s.; Tuesday, £111 15s. to £111 17s. 6d.; Wednesday, £110 7s. 6d. to £110 10s.

Three Months.—Thursday, £109 17s. 6d. to £110; Friday, £114 15s. to £114 17s. 6d.; Monday, £114 12s. 6d. to £114 15s.; Tuesday, £113 15s. to £113 17s. 6d.; Wednesday, £112 7s. 6d. to £112 10s.

Spelter.—There is a moderate demand for spelter, and the outlook is perhaps more favourable than it has been in recent weeks.

Daily fluctuations :—

Ordinary. — Thursday, £12 3s. 9d.; Friday, £12 15s.; Monday, £12 12s. 6d.; Tuesday, £12 8s. 9d.; Wednesday, £12 6s. 3d.

Lead.—Were it not for the financial troubles in Germany, the demand for this metal would have been moderately good. As it is, the situation is not unfavourable.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £12 6s. 3d.; Friday, £12 18s. 9d.; Monday, £12 16s. 3d.; Tuesday, £12 17s. 6d.; Wednesday, £12 16s. 3d.

The Acid Bessemer Process in Sweden.—Mr. Arvid Johansson, in a recent issue of "Jernkontorets Annaler," after giving an historical account of the foundation and development of the acid Bessemer process in Sweden during the last century, relates his own personal experiences of this process. According to him the experiences gained in the Swedish acid Bessemer practice may to a certain extent be applied to the acid open-hearth process. On account of the very vigorous mixing of the steel bath during the former process, an equilibrium between slag and steel bath is more closely reached. If the process is normal, and no additions have to be made during the blowing, the oxygen content of the steel will during the whole process be low, and the steel will in fact at no period be red short, which is of great importance for the production of high-quality steel. In order to obtain similar conditions in the acid open-hearth process, the melting should be done as rapidly as possible, and the temperature then be raised until boiling begins. The ore should not be added too early, and in fairly small quantities from time to time.

The Iron-Carbon-Vanadium System.

A report of an investigation by Herr Hans Hougardy, carried out in the Research Laboratory of the United Steelworks in Dortmund, on the influence of vanadium on the properties of carbon steels, was published in a recent issue of "Archiv für das Eisenhüttenwesen." For this purpose a series of special alloys were prepared with eight different carbon percentages ranging from 0.10 to 3.0. Four groups of these up to 1.0 per cent. carbon were alloyed with six different amounts of vanadium from 0.4 to 5.6 per cent., while those with 1.5 per cent. carbon and upwards were alloyed with 8.0, 12.0 and 16.0 per cent. vanadium respectively.

It was shown that the characteristic effect of vanadium—namely, the suppression of the α-γ change in pure iron with 1.1 per cent. vanadium—is not prevented by the presence of carbon, but merely displaced to a higher percentage of vanadium, which increases with increasing carbon content. The amount of vanadium required to suppress this change to gamma in carbon steels can be calculated by the formula

$$V = \frac{C}{0.175} + 1.1.$$

Since vanadium carbide is insoluble both in α- and δ-iron, as it does not go into solution at the A_1 point and is only soluble to a limited extent in γ-iron, the correlations between iron and carbon can only be determined from the quantity of iron carbide present.

On plotting the critical points of the iron-carbon-vanadium alloys in relation to the carbon content, these were found to be parallel to the lines of the iron-carbon system, being simply shifted to the right—*i.e.*, to higher carbon contents. On the other hand, plotted on a base of the iron-carbide content, the two systems iron-carbon-vanadium and iron-carbon coincide.

Vanadium thus, in suitably high proportions, gives to carbon steels the properties of low-carbon steels, and, beyond that even the properties of carbon-free iron, with all the characteristic qualities associated therewith.

Continental Steel Cartel.

The present scheme for the renewal of the Continental Steel Cartel provides for its re-establishment for a period of five years, provided an international sales syndicate for semi-finished products is formed within a year and one for joists within two years. Otherwise, each national group after one or two years will regain its freedom of activity, that is to say, any group will be able to give notice to terminate the Cartel. This clause in regard to the sales syndicates was demanded by all the groups.

The Belgian works are stated to require the question of territorial protection as affecting themselves to be settled before fixing the national quotas. It is thought that the negotiations will be broken off if an agreement is not reached at least on questions of principle, especially in the matter of quotas and territorial protection. The penalty for excess production, under the renewed Cartel, has been fixed at $10 to $15 per ton, a rate which is calculated to deter any group from exceeding its quota.

Monel metal can be pickled in a bath composed of: 1.7 lb. sulphuric acid, 0.7 lb. sodium chloride, 0.6 lb. Chili saltpetre and one gallon of water. A bath temperature of 60 deg. F. should be used.

Hints for Commercial Visit to Estonia.—A memorandum containing hints for the guidance of commercial visitors to Estonia has been prepared by the British Consul at Tallinn (the place known as Reval before the war). United Kingdom firms interested may obtain copies on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1 (quoting Reference No. C. 3558).

★ *A Pamphlet for which all Foundry Managers and Foremen should write.*

'UCO' CYLINDER IRONS

Low total Carbon with low Silicon content . .

These irons are produced with varying total carbon. The low total carbon is a feature very much sought after by almost every foundryman and particularly by those making all types of cylinders, pistons, cylinder linings, etc. Used either separately or together, these irons provide an excellent base iron for the manufacture of castings such as Diesel Cylinders and all castings subjected to heavy wear and high stresses.

RANGE OF ANALYSES AVAILABLE

	Medium Total Carbon Cylinder Iron.	Low Total Carbon Cylinder Iron.	Low Total Carbon Cylinder Iron, with Medium Phosphorus
Total Carbon . .	3.1% to 3.4%	2.7% to 3.1%	2.7% to 3.1%
Silicon	0.7% to 1.5%	1.2% to 1.7%	1.2% to 2.0%
Sulphur	.06% Max.	.06% Max.	.06% Max.
Phosphorus . .	.06%	.06%	0.3% to 0.4%
Manganese . . .	0.1% to 1.0%	0.1% to 1.0%	0.5% to 1.2%

Sulphur may be obtained lower, if desired. A complete analysis accompanies each consignment.

"UCO" CYLINDER IRONS

and the mixtures made by using them, are suitable for the following variety of castings:

CYLINDERS OF ALL CLASSES, *i.e.* DIESEL, INTERNAL COMBUSTION CYLINDERS, CYLINDER LINERS, ——— ETC. ———

CENTRIFUGAL PUMP CASINGS
CHILLED AND GRAIN ROLLS
HEAT RESISTING CASTINGS

PISTONS
PISTON RINGS
ROLLS
VALVES AND VALVE BODIES
——— ETC. ———

This short list does not include many uses to which "UCO" Cylinder Irons are suited, but will suggest to foundrymen and engineers the class of work for which "UCO" has been found exceedingly valuable both in Great Britain and in countries abroad.

★ *A copy of our brochure "UCO All-Mine Cylinder Irons" will be sent post free on receipt of the attached coupon.*

WORKINGTON IRON & STEEL COMPANY

Branch of The United Steel Companies Ltd.

WORKINGTON CUMBERLAND

Write for this if you make castings subject to wear or stress.

To THE PUBLICITY DEPARTMENT,
The UNITED STEEL COMPANIES LIMITED, SHEFFIELD.

Please send copy of "UCO All-Mine Cylinder Irons" to:

Name .....

Firm's Name .....

.....

Firm's Address .....

.....

Position in Firm .....

℗W6a

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	34	2	6
Three months	34	17	6
Electrolytic	37	0	0
Tough	35	5	0
Best selected	35	15	0
Sheets	64	0	0
India	45	15	0
Wire bars	38	7	6
Do., September	38	7	6
Do., October	38	7	6
Ingot bars	38	7	6
H.C. wire rods	40	0	0
Off. av. cash, June	35	17	6 15/16
Do., 3 mths., June	36	10	10 1/16
Do., Sttlmnt., June	35	17	4 7/16
Do., Electro, June	39	7	10 1/16
Do., B.S., June	37	10	10
Do., wire bars, June	39	16	4 5/16
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	110	7	6
Three months	112	7	6
English	111	5	0
Bars	114	15	0
Straits	113	5	0
Australian	112	15	0
Eastern	115	12	6
Banca	116	0	0
Off. av. cash, June	105	0	8 3/16
Do., 3 mths., June	106	13	5 13/16
Do., Sttlmt., June	105	1	1 7/16

SPELTER.

	£	s.	d.
Ordinary	12	6	3
Remelted	11	10	0
Hard	9	5	0
Electro 99.9	14	15	0
English	12	17	6
India	11	10	0
Zinc dust	19	0	0
Zinc ashes	3	0	0
Off. aver., June	11	10	2 1/16
Aver. spot, June	11	5	4 1/32

LEAD.

	£	s.	d.
Soft foreign ppt.	12	16	3
English	14	5	0
Off. average, June	11	15	4 1/16
Average spot, June	11	11	7 1/32

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	10	0
Do., V.M. ex-whf.	19	5	0
Rods	22	0	0
Boiler plates	14	0	0
Battery plates	16	0	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	34	0	0
Chinese	22	15	0
Crude	21	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	16	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 7 6
45/50%	£10 7 6
75%	£15 2 6
Ferro-vanadium—	
35/50%	£12 8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9½d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£28 0 0
4/6% car.	£21 5 0
6/8% car.	£20 12 6
8/10% car.	£19 17 6
Ferro-chrome—	
Max. 2% car.	£29 17 6
Max. 1% car.	£33 15 0
Max. 0·70% car.	£35 12 6
70% carbon-free	9½d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	8/9 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose £10 15 0 to £11 5 0	
76/80% packed £11 15 0 to £12 5 0	
76/80% export (nom.) £9 0 0	
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales						
Heavy steel				2	0	0
Bundled steel and shrngs.	1	15	0 to	1	16	0
Mixed iron and steel				1	16	0
Heavy cast iron	2	0	0 to	2	2	6
Good machinery for foundries				2	5	0
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	5	0
Cast-iron borings				1	2	0
Heavy forge				2	13	0
W.I. piling scrap				2	10	0
Cast-iron scrap	2	2	6 to	2	4	0
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought				2	7	6
Steel turnings					—	
Scotland—						
Heavy steel				1	17	6
Ordinary cast iron				2	0	0
Engineers' turnings				1	5	0
Cast-iron borings				1	10	0
Wrought-iron piling				2	7	6
Heavy machinery				2	8	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	18	0	0
Lead (less usual draft)	10	0	0
Tea lead	7	0	0
Zinc	6	0	0
New aluminium cuttings	52	0	0
Braziery copper	24	0	0
Gunmetal	23	0	0
Hollow pewter	72	0	0
Shaped black pewter	53	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	62/6
Hematite M/Nos.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	71/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands—	
Staffs common*	—
„ No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	73/6
„ No. 3	71/-
Hem. M/Nos. d/d	70/-
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	76/6
W.C. hematite	82/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/6
Clyde, No. 3	87/6
Monkland, No. 3	87/6
Summerlee, No. 3	87/6
Eglinton, No. 3	87/6
Gartsherrie, No. 3	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	15	0 to	10	0	0
Nut and bolt iron	8	10	0 to	8	12	6
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	9	0	0 to	9	15	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 12 6 & up.			
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	5	0
Black sheets, 24g.	8	5	0 to	9	5	0
Galv.cor.shts.24g.	9	10	0 to	9	15	0
Galv. flat sheets	10	0	0 to	10	5	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft				5	0	0
Billets, hard				6	12	6
Sheet bars	4	12	6 to	4	17	6
Tin bars				4	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	12d.
Wire	12d.
Rods	11½d.
Tubes	1/6d.
Castings	11¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.01
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	17.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.85
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.00
Wire nails	1.80
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	14/- to 15/-
Durham and Northumberland—	
„ foundry	13/-
„ furnace	13/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		13/6
„	28×20	„	27/-
„	20×10	„	20/-
„	18¾×14	„	14/6
C.W.	20×14	„	13/-
„	28×20	„	27/-
„	20×10	„	19/7½
„	18¾×14	„	14/6
Terneplates	28×20		27/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
July 16 ..	33	5	0	No change	
,, 17 ..	34	17	6	inc.	32/6
,, 20 ..	34	15	0	dec.	2/6
,, 21 ..	34	12	6	,,	2/6
,, 22 ..	34	2	6	,,	10/-

Electrolytic Copper.

		£	s.	d.	
July 16 ..	36	0	0	No change	
,, 17 ..	36	0	0	,, ,,	
,, 20 ..	37	0	0	inc.	20/-
,, 21 ..	37	0	0	No change	
,, 22 ..	37	0	0	,, ,,	

Standard Tin (cash).

		£	s.	d.	
July 16 ..	108	0	0	inc.	5/-
,, 17 ..	112	15	0	,,	95/-
,, 20 ..	112	12	6	dec.	2/6
,, 21 ..	111	15	0	,,	17/6
,, 22 ..	110	7	6	,,	27/6

Tin (English ingots).

		£	s.	d.	
July 16 ..	109	0	0	dec.	5/-
,, 17 ..	114	0	0	inc.	100/-
,, 20 ..	113	15	0	dec.	5/-
,, 21 ..	112	15	0	,,	20/-
,, 22 ..	111	5	0	,,	30/-

Zinc Sheets (English).

		£	s.	d.	
July 16 ..	20	0	0	No change	
,, 17 ..	20	10	0	inc.	10/-
,, 20 ..	20	10	0	No change	
,, 21 ..	20	10	0	,,	,,
,, 22 ..	20	10	0	,,	,,

Spelter (ordinary).

		£	s.	d.	
July 16 ..	12	3	9	dec.	3/9
,, 17 ..	12	15	0	inc.	11/3
,, 20 ..	12	12	6	dec.	2/6
,, 21 ..	12	8	9	,,	3/9
,, 22 ..	12	6	3	,,	2/6

Lead (English).

		£	s.	d.	
July 16 ..	13	15	0	No change	
,, 17 ..	14	5	0	inc.	10/-
,, 20 ..	14	5	0	No change	
,, 21 ..	14	5	0	,,	,,
,, 22 ..	14	5	0	,,	,,

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 5 6	2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	—	—	—	—	—	—	—	—

* No prices available during strike period.

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